SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-77-14

ENGINEERING SOILS MAP OF MORGAN COUNTY, INDIANA

P. T. Yeh

PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

ENGINEERING SOILS MAP OF MORGAN COUNTY, INDIANA

TO: J. F. McLaughlin, Director
Joint Highway Research Project

September 7, 1977

File: 1-5-2-60

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-51B

The attached report, entitled "Engineering Soils Map of Morgan County, Indiana", completes a portion of the project concerned with development of County engineering soils map of the State of Indiana. This is the 60th report of the series. The report was prepared by Dr. P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Morgan County was done primarily by airphoto interpretation. Some test data along Interstate 70, SR 37 and SR 67 are included in the report. Generalized soil profiles of the major soil from each land form are presented on the engineering soils map. An ozalid print of the Engineering Soils Map of Morgan County is included in the report.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
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Final Report

ENGINEERING SOILS MAP OF MORGAN COUNTY, INDIANA

by

P. T. Yeh
Research Engineer

Joint Highway Research Project

Project No.: C-36-51B

File No.: 1-5-2-60

Prepared as part of an investigation

conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

In cooperation with

Indiana State Highway Commission

Purdue University
West Lafayette, Indiana

September 7, 1977

ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance given by all those persons who have helped in the preparation of the report. Special acknowledgments are due the members of the Advisory Board, Joint Highway Research Project for their active interest in furthering the study; Professor R. D. Miles, in charge of the Airphoto Interpretation, Photogrammetry and Site Selection Laboratory for review and suggestion; and Mr. Ralph H. Sturm, Area Soil Scientist, Soil Conservation Service, United States Department of Agriculture for his effort in furnishing valuable soil information for Morgan County.

All airphoto used in connection with the preparation of this report automatically carried the following credit line: Photographed for Commodity Stabilization Service, Performance and Aerial Photography Division, United States, Department of Agriculture.

ENGINEERING SOILS MAP

OF

MORGAN COUNTY, INDIANA

INTRODUCTION

The engineering soils map of Morgan County, Indiana which accompanies this report was done primarily by airphoto interpretation. The aerial photographs, having an approximate scale of 1:20,000, were taken in July 1939 for the United States Department of Agriculture and were purchased from that agency.

Aerial photographic interpretation of the land forms and engineering soils of this county was accomplished in accordance with accepted principles of observation and inference (1)*. A field trip was made to the area for the purposes of resolving ambiguous details and correlating aerial photographic patterns with soil texture. Standard symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms and soil textures. The text of this report largely represents an effort to overcome the limitation imposed by adherence to a standard symbolism and map presentation.

Although no soil samples were collected and tested by the staff of the Joint Highway Research Project, general soil profiles were developed and are shown on the soils map. The soil profiles were compiled from the agricultural literature and from the boring data of the roadway soil survey along I-70, SR 67 and SR 37 supplied by the State Highway Commission. Liberal reference was made to the "Formation Distribution and Engineering Characteristic of Soils" (2), and to the "Soil Survey of Morgan County, Indiana" (3).

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*Number in parentheses indicate reference in the bibliography.

DESCRIPTION OF THE AREA

General

Morgan County is located in the central part of Indiana. Martinsville, the county seat, is only 30 miles (48.3 km) south-west of Indianapolis. The county is nearly a square in shape except for a small irregular offset in the northwestern corner. The county is bounded on the east by Johnson County, on the north by Marion and Hendricks counties, on the west by Putnam and Owen counties and on the south by Monroe and Brown counties (Figure 1). The length from north to south is about 19 miles (30.6 km) and the greatest distance east and west is about 23 miles (35.4 km). The included area of Morgan County is approximately 406 square miles or 259,840 acres (1050 sq. km) (4).

Martinsville, located about 2.5 miles (4 km) from the geometric center of the county, is the largest city and the seat of the government of Morgan County. The city had a population of 9,723 while the county population totaled 44,176 as reported in the 1970 census (5).

According to the 1964 Census of Agriculture 61.7% of Morgan County or 160,377 acres (650 sq. km) was farm land (4). There were 31,280 acres (126.6 sq. km)of wooded land in the county which was generally confined to the sandstone and shale region in the central and southern parts of the county and along the steep bluffs and gullies of rivers and streams as shown in Figure 2.

Drainage Features

Morgan County lies within the White River drainage basin of the state. The county is drained by the West Fork White River and its tributaries. The area located at the northwestern corner is drained into Mill Creek tributary of Eel River which joins the West Fork White River in Greene County.

The West Fork White River crosses the county from northeast to southwest. The major tributaries from the north are White Lick Creek, Sycamore Creek and Lambs Creek (Burnett Creek in

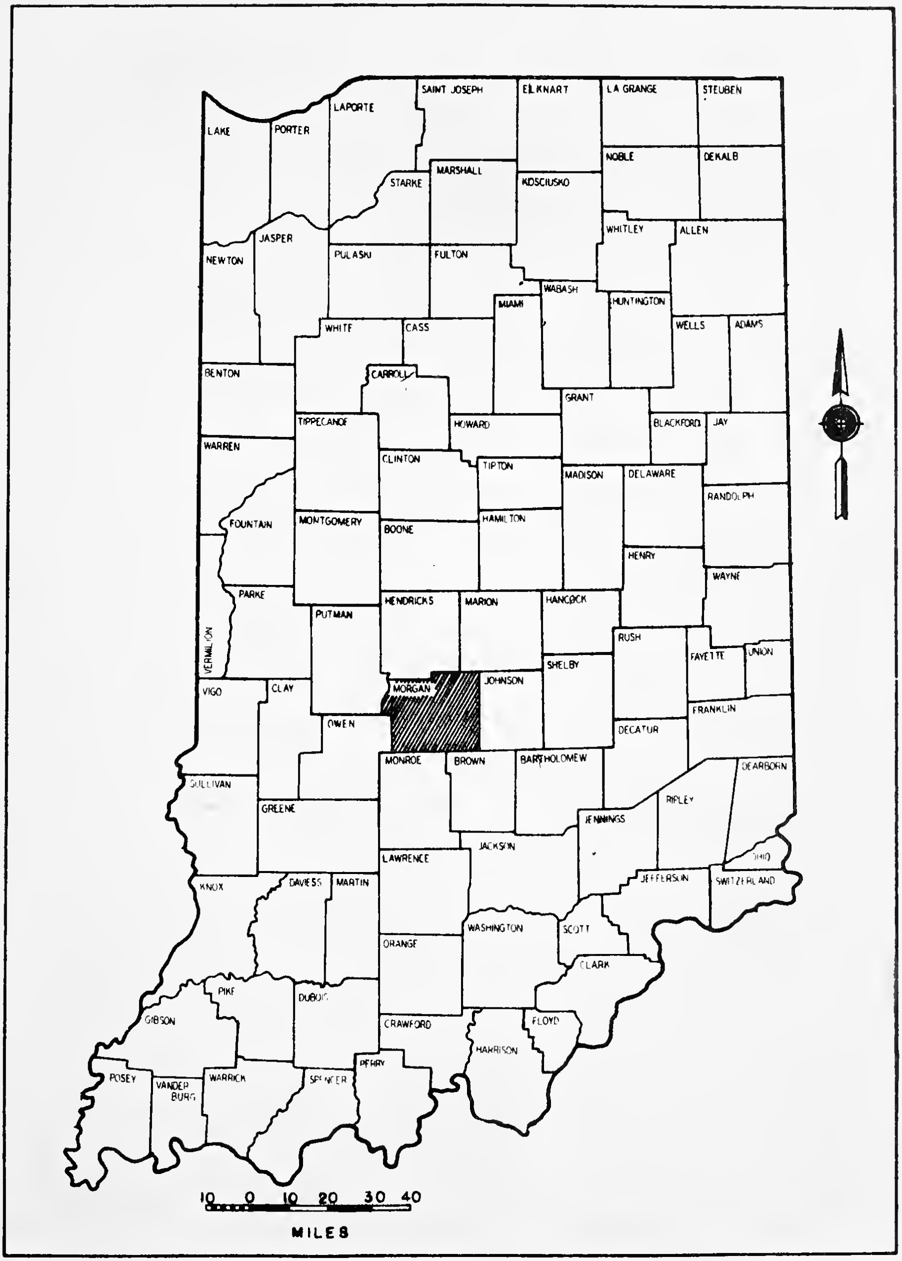


FIGURE I LOCATION MAP OF MORGAN COUNTY

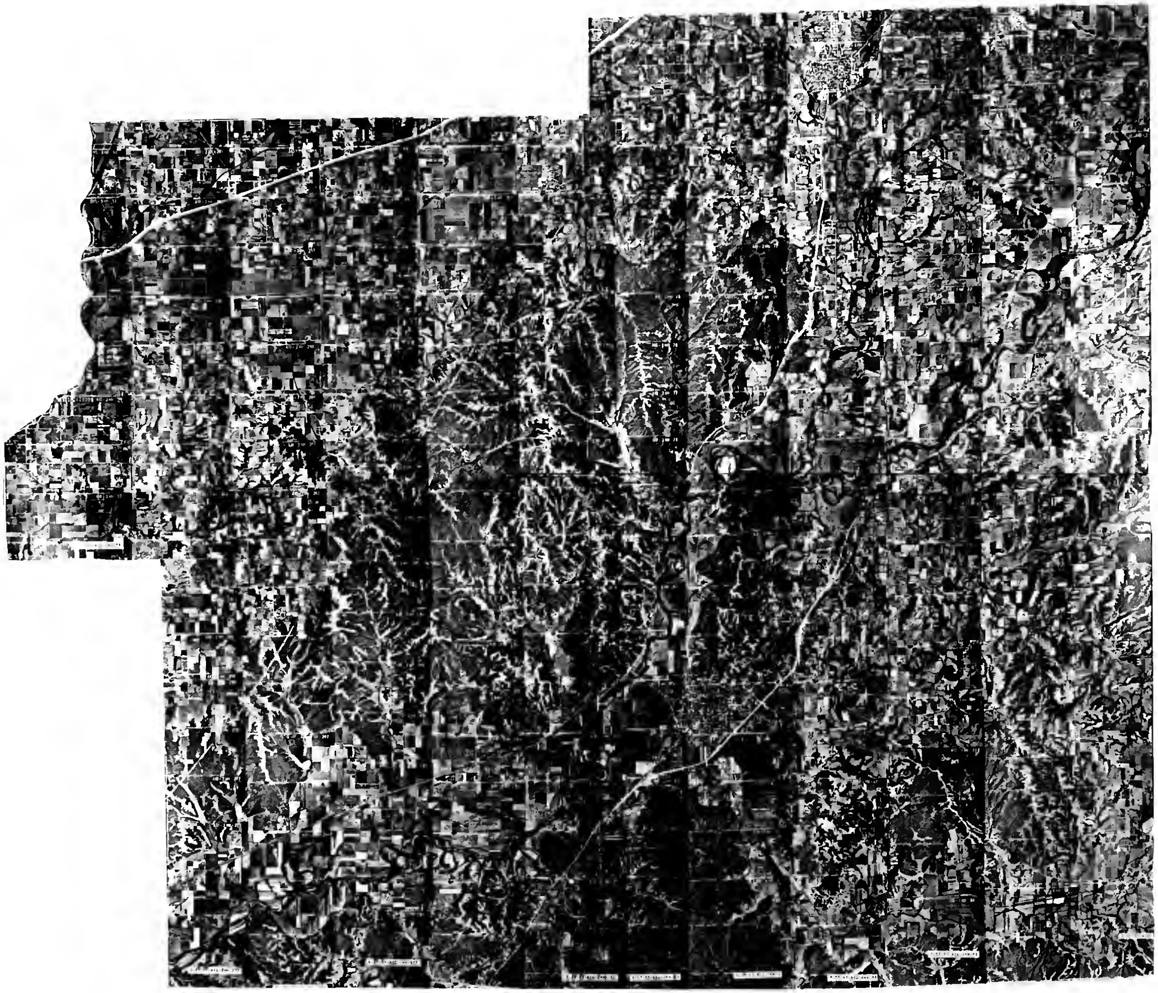


FIG. 2. AIRPHOTO MOSAIC OF MORGAN COUNTY, INDIANA

FROM 1967 INDEX MAP

the 1949 drainage map). The major tributaries from the south are Crooked Creek, Stotts Creek, Clear Creek, Indiana Creek and Bryants Creek. The courses of the Crooked Creek and Stotts Creek are deflected down stream before they empty their water into the West Fork White River (See Figure 3). Rock control of drainage courses can be detected from the drainage map in many places.

Ditches have been constructed in the nearly level portions at the northwestern part of the county to improve sluggish drainage conditions. Most of the ditches are in the glacial lake bed areas. Mill Creek and Lake ditch (named Adams Creek in the drainage map) and its tributaries have been dredged extensively.

Upland drainage systems are generally well developed, especially near the principal streams; most of the drainage patterns are fine-textured; some of the stream valleys are ravine-like especially in the sandstone shale region. Many streams flow on rock in portions of their courses.

Some subterrain drainage can be observed from the sinkhole and kettle hole patterns on the drainage map. The sinkhole pattern is confined to the limestone region at the western part of the county. The kettle hole pattern occurs about four miles (6.5 km)northeast of Martinsville.

There are no natural lakes in Morgan County. Artificial lakes and ponds of various origins are scattered throughout the area. The largest is Patton Lake located about five miles (9 km) northwest of Martinsville. The other body of water of considerable size located east of Martinsville are ponds of fish hatchery.

Climate

The climate of Morgan County is continental, humid and temporate with hot summers and cold winters. The mean annual precipitation is 40.39 inches (103 cm) at Martinsville. The summary of temperature and precipitation and the extremes data in the following tables was compiled by the U. S. Department of Commerce, weather bureau, in cooperation with Purdue Agricultural Experiment Station (6).

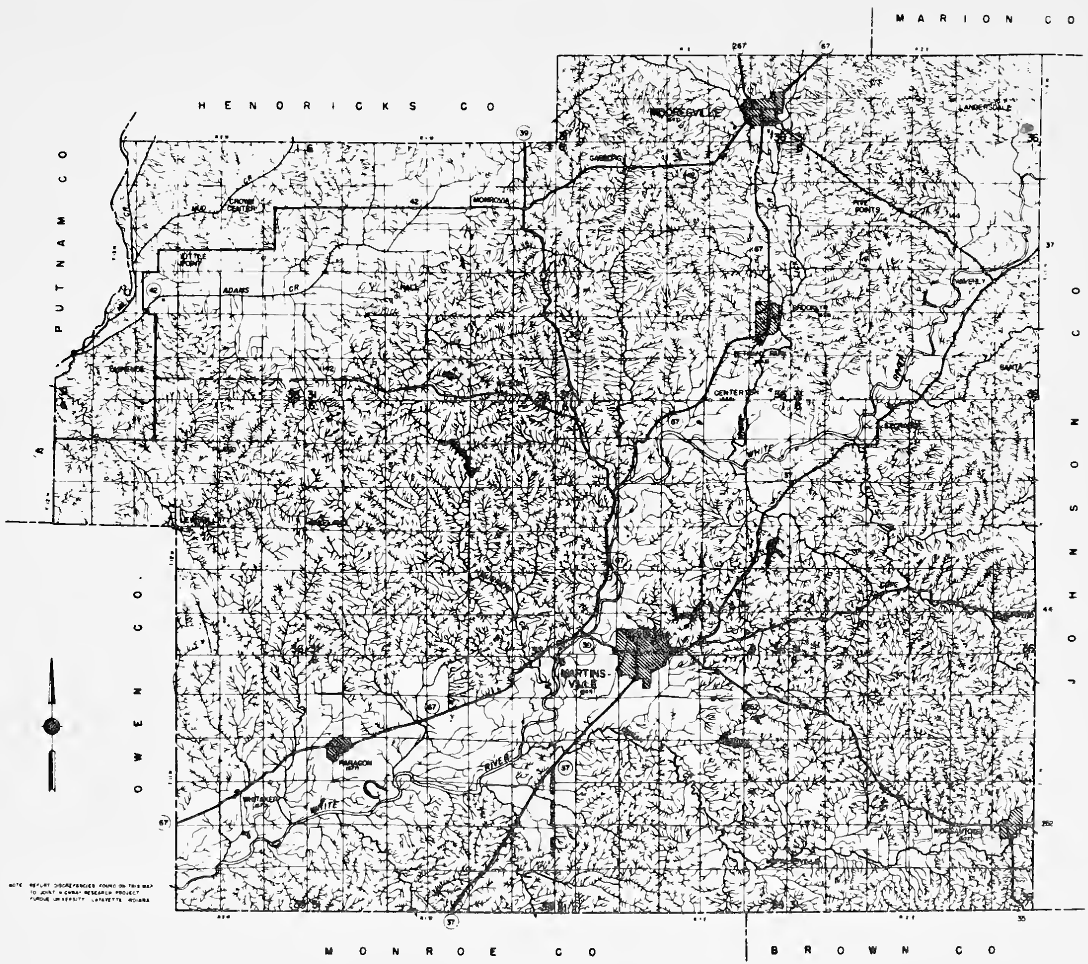


FIGURE 3 DRAINAGE MAP

MORGAN COUNTY

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 — 12

LATITUDE 39° 25' N.
LONGITUDE 86° 26' W.
ELEV. (GROUND) 607 Ft.

CLIMATOLOGICAL SUMMARY

STATION MARTINSVILLE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1935-1964 (Temperature, 1951-1964)

	Temperature (°F)							**	Precipitation Totals (Inches)									Mean number of days				
	Means			Extremes								Snow, Sleet (b)							Temperatures			
																			Max.		Min.	
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	Month
(a)	14	14	14	14		14		11	30	30		30	30		30		11	14	14	14	14	
Jan.	38.1	18.7	28.4	70	1960+	-24	1963	1179	3.07	2.63	1950	3.7	10.5	1956	6.0	1937	5	0	10	28	3	Jan.
Feb.	42.6	22.3	32.5	71	1954	-16	1951	952	2.60	2.18	1949	2.9	13.0	1934	5.0	1951	5	0	5	24	1	Feb.
Mar.	49.9	29.2	39.6	80	1963	- 5	1960	787	3.85	2.55	1938	2.9	13.0	1951	6.0	1953	8	0	2	21	*	Mar.
Apr.	64.3	41.6	53.0	88	1960+	19	1964+	372	3.80	2.49	1957	*	3.0	1940	3.0	1940	6	0	0	6	0	Apr.
May	74.8	51.1	63.0	94	1952	26	1963	139	4.46	3.46	1961	T	T	1951	T	1951	9	1	0	1	0	May
June	83.9	60.1	72.0	104	1954	38	1956	24	4.78	5.02	1960	0	0		0		6	8	0	0	0	June
July	87.2	63.1	75.2	105	1954	42	1960	2	3.91	3.50	1936	0	0		0		7	11	0	0	0	July
Aug.	86.1	60.3	73.2	100	1956	42	1954+	8	3.09	3.70	1934	0	0		0		5	9	0	0	0	Aug.
Sept.	80.5	52.0	66.3	103	1954	31	1964	81	2.96	2.46	1962	0	0		0		4	5	0	*	0	Sept.
Oct.	69.2	40.2	54.7	92	1954+	15	1952	332	2.24	2.25	1937	T	T	1962+	T	1954+	5	*	0	6	0	Oct.
Nov.	53.1	30.0	41.6	80	1961+	- 2	1958	691	3.23	4.57	1942	1.0	8.0	1932	5.0	1950	6	0	1	19	*	Nov.
Dec.	40.1	21.0	30.6	71	1956	-18	1963	1082	2.40	1.95	1956	3.7	10.2	1929	7.2	1945	5	0	8	26	2	Dec.
Year	64.2	40.8	52.5	105	July 1954	-24	Jan. 1963	5649	40.39	5.02	June 1960	12.2	13.0	Mar. 1951+	7.2	Dec. 1945	71	34	26	131	6	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

(b) Snowfall not measured several years; some earlier data used.

CLIMATE OF MARTINSVILLE, INDIANA

Martinsville, the seat of Morgan County, is located approximately half way between Indianapolis and Bloomington, Indiana. It has been known for many generations as the place where people may rest from life's battle of nerves and lose their aches and pains. Martinsville is a noted spa, the outgrowth of the discovery of mineral water while drilling for gas in 1885. People come to this city to take mineral baths, to enjoy the environment, and to confer with health specialists. Central Indiana climate is an important attribute to the popularity of the community.

Weather changes every few days come from the passing of weather fronts and associated centers of low and high pressure. In general, a high brings lower temperatures, lower humidity and sunny days. An approaching low brings increasing temperatures, increasing southerly wind, higher humidity, and commencement of rain or showers. This activity is greatest in the spring and least in late summer and early fall.

Precipitation is rather evenly distributed throughout the year, a happy contrast to some areas of the United States that have a "dry season" and require irrigation to maintain green vegetation. The table of monthly rainfall for past years in this report shows the variation of rainfall that may be expected. There is a tendency for spring and early summer rains to exceed winter precipitation. The spring rains are very reliable insuring near maximum soil moisture going into summer when evaporation losses exceed rainfall and dry soils become more probable. A severe drought has never been experienced in this locality. About one-third of the annual rainfall flows into streams and out of the area. Future needs may require conservation of this water.

The probability for unusually heavy rains in just a few hours is indicated by a weather study of the area:

Frequency in 100 years	Rain in 1 hour	6 hours	12 hours
4	2.4	4.0	4.6
10	2.1	3.3	3.8
20	1.7	2.8	3.2

Snowfall has varied reception. None occurs in the summer. Some winters have much snow and others have very little. An occasional snow storm may hamper travel and clog roads but at the same time the blanket of snow protects winter grains from the very cold air that invariably follows. Heaviest snow storms are those out of the southwest. As they swirl northeastward, abundant moisture flows in from the Gulf of Mexico. A storm out of the northwest, with an inward flow of colder, drier air, leaves less snow. Some midwinters are thus cold but snowfall is normal or less.

Relative humidity is not measured at this station but estimates are possible from the climatology of the area. Relative humidity varies on sunny summer days from a percent in the 40's in the early afternoon to the 90's about sunrise. Relative humidity rises and falls much as temperature does during a typical day but the highest percent usually occurs with the minimum temperature and the lowest percent with the maximum temperature. A cold front is next in importance in changing relative humidity downward.

Winds blow most frequently from the southwest, however, in one or two of the winter months, prevailing winds are northwest. Damaging winds have three sources. In the order of diminishing areal coverage but increasing intensity, they are: lows passing through the region, thunderstorms, and tornadoes. Only 9 tornadoes have been reported in the County since 1916. Very few were of sufficient size to injure people or property. Thunderstorms, including incidences of lightning and thunder, occur about 48 days of the year. Most of these occur in the spring and early summer. They are seldom so severe as to cause loss of life, property, or crops.

Heating degree days in the above table provide a comparative number for calculating heating requirements between different places and different times. Fuel consumption for heating is proportional to degree day totals, so a month with twice the heating degree days of another month requires twice as much fuel for heating. Degree days for a single month are obtained by subtracting the mean temperature from 65 degrees.

The growing season (defined here as the number of days between the last spring and first fall temperature of 32°F.) averages 172 days in length for the period covered by this summary. Freezing temperatures have occurred as late as May 27, in the spring, and in the fall, as early as September 14.

Many days of the year are nearly ideal in temperature. A few days, in the summer when temperatures exceed 90, or decline below zero in the winter, tend to obscure this fact. The fall season is considered by many as the best time of the year for outdoor activities. Spring is also a favorite season but actually this season has more days of rain and thunderstorms. In the fall the atmosphere in total seems more quiet. Air and soil temperatures are nearer in agreement than at any other time of the year, thus, convective activity is diminished. Many days are sunny and showers are less frequent.

Lawrence A. Schaal
Weather Bureau State Climatologist
Purdue University, Agronomy Department
Lafayette, Indiana

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1951	31.4	31.3	39.4	49.7	65.1	71.4	75.2	73.5	64.5	57.7	35.6	31.4	52.2
1952	35.3	36.4	41.1	52.4	62.7	77.3	77.6	72.3	64.3	48.6	42.7	33.6	53.7
1953	32.7	35.3	41.6	48.8	65.1	76.6	75.2	73.2	67.1	57.4	44.0	33.4	54.2
1954	31.2	40.8	38.8	57.8	58.4	75.6	78.5	75.2	70.3	56.0	42.0	33.4	54.8
1955	29.3	32.7	41.8	58.3	64.0	67.1	80.2	76.8	69.3	54.4	39.9	29.2	53.6
1956	28.1	35.3	41.5	50.5	63.6	72.6	74.4	74.4	64.7	59.7	42.0	39.1	53.8
1957	24.8	38.2	42.3	55.1	63.3	73.0	76.0	72.9	63.4	49.9	40.2	35.6	52.9
1958	28.7	25.2	36.3	-	61.2	68.3	74.0	72.3	65.7	54.2	45.0	25.1	-
1959	26.2	32.6	39.9	54.0	67.7	72.9	75.6	77.0	68.4	53.3	36.8	36.6	53.4
1960	31.9	28.5	26.8	55.5	59.6	69.7	71.8	74.2	69.1	52.5	41.7	23.3	50.4
1961	22.6	34.1	44.3	46.9	57.0	68.7	73.7	72.2	69.8	55.8	42.1	30.6	51.5
1962	26.2	31.9	37.9	50.1	68.8	71.4	73.2	71.7	62.3	57.1	41.2	26.1	51.5
1963	19.2	22.4	42.7	54.0	59.3	71.0	72.4	69.2	64.0	60.2	44.3	19.1	49.8
1964	30.7	29.5	40.3	54.9	65.2	72.2	74.2	70.7	64.8	49.4	44.4	31.6	52.3

STATION HISTORY

This climatological study of the Martinsville area has been made possible through the efforts of citizens of the community who have given generously of their time to read, record, and report weather information from government instruments seven days a week, over the period of years covered by this summary. The first observer was Edward T. Woodward who reported from December 20, 1922 until March 8, 1927 at 608 E. Jackson Street. The next observer was Robert N. Sisson with the statinn located at 60 South Marion Street, 3½ blocks East of the Post Office, from March 9, 1927 until May, 1936. Mr. Sisson continued as observer from May, 1936 until December 30, 1940 at 40 South Mulberry Street, 2½ blocks East of the Post Office. Succeeding Mr. Sisson was Maurice T. Ennis from December 31, 1940 to December 31, 1956 at a location 0.1 mile East of the Post Office on City property East of the City Hall. At the same location, Ira S. Cramer was the observer from January 1, 1957 to February 28, 1958. From March 1, 1958 to March 21, 1961, observations were made at the Fire Department, 0.1 mile East of the Post Office. Since March 21, 1961, the station location has been at the City Sewage Plant, John P. Sichting making the reports through August, 1962. Presently reporting is Warren M. Schnaiter who assumed this duty in September, 1962.

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	1.37	1.30	2.77	1.70	1.84	5.84	3.44	6.61	5.54	0.30	1.53	1.48	33.72
1935	2.30	0.53	3.83	1.94	7.14	4.98	2.33	1.77	4.52	2.20	3.64	1.85	37.03
1936	1.81	2.55	2.90	4.62	0.83	1.21	5.51	2.11	4.30	4.89	4.16	3.53	38.42
1937	9.58	1.79	2.23	3.70	2.74	4.49	4.64	3.76	3.76	5.65	0.73	3.07	46.14
1938	1.13	4.17	10.17	1.15	5.85	6.51	2.79	3.33	2.26	1.42	4.06	1.31	44.15
1939	9.00	5.28	3.88	6.38	1.20	5.50	2.70	1.47	0.89	1.98	1.35	0.75	40.38
1940	1.90	3.62	1.23	6.39	3.23	3.23	1.44	2.26	1.17	1.44	3.35	1.52	30.78
1941	1.39	0.80	0.39	2.15	1.59	5.92	0.87	1.83	5.06	6.68	3.60	2.01	32.29
1942	0.96	3.87	3.58	3.31	4.74	8.49	2.44	6.34	3.62	1.50	7.57	1.65	48.07
1943	0.59	1.80	4.43	2.43	8.96	4.92	2.96	2.02	4.12	1.39	1.27	1.83	36.72
1944	0.29	2.92	4.30	7.58	3.19	0.85	0.75	2.64	2.24	0.67	1.82	1.57	28.82
1945	0.93	3.31	7.79	4.51	3.46	7.24	3.53	3.81	5.39	1.73	3.23	2.69	47.62
1946	1.32	3.03	3.29	1.69	6.49	1.75	2.19	4.87	1.19	1.80	3.95	3.82	35.39
1947	4.55	0.16	2.10	7.07	6.20	7.78	3.17	3.97	3.83	2.01	1.46	1.58	43.88
1948	2.82	2.36	4.64	3.17	2.56	5.01	6.02	2.51	3.85	2.97	5.45	-	-
1949	7.77	3.09	4.27	1.43	3.72	5.28	3.87	4.22	4.24	3.56	0.86	3.77	46.08
1950	11.26	5.35	3.84	3.28	3.59	5.26	2.13	2.78	5.91	1.19	6.84	2.51	53.94
1951	3.29	3.41	2.98	2.84	3.22	5.71	6.03	1.49	2.55	1.71	6.16	4.97	44.36
1952	3.59	2.72	3.96	4.56	3.96	8.32	2.99	3.52	3.44	0.48	3.29	2.10	42.93
1953	2.84	1.42	6.70	3.25	4.22	2.78	7.28	3.57	0.98	1.43	2.32	2.30	39.09
1954	3.99	2.46	2.20	3.18	1.93	2.35	1.92	3.48	1.64	4.79	1.24	2.31	31.49
1955	2.30	2.67	3.86	4.08	4.09	2.54	4.35	2.86	5.25	2.82	6.29	0.70	41.81
1956	1.50	3.67	2.05	3.43	6.57	5.27	2.38	3.42	2.15	0.68	2.68	4.23	38.03
1957	2.95	1.88	1.79	6.92	10.96	9.36	6.53	1.65	2.23	2.30	3.53	7.15	57.25
1958	1.42	0.31	1.52	3.16	5.05	9.09	7.30	3.88	3.46	2.12	4.12	0.35	41.78
1959	4.51	3.60	2.79	3.49	6.19	2.40	2.73	4.36	2.57	3.21	2.61	3.06	41.52
1960	2.63	3.32	0.98	1.42	5.00	8.20	2.35	2.05	0.75	1.42	2.08	2.04	32.24
1961	0.84	3.82	5.92	4.35	7.77	3.02	8.00	1.03	2.89	3.05	2.83	2.89	46.41
1962	2.86	2.12	3.20	1.25	5.46	1.19	8.92	5.17	3.19	1.23	1.52	1.46	37.57
1963	0.66	0.27	7.60	2.85	3.16	1.72	5.22	3.91	0.28	0.36	2.26	0.55	28.84
1964	1.18	1.56	7.07	8.30	0.73	3.23	4.06	2.68	1.01	0.65	2.72	2.16	35.35

DATES OF OCCURRENCE OF CRITICAL TEMPERATURES

	Last in Spring					First in Fall				
Year	16 or lower	20 or lower	24 or lower	28 or lower	32 or lower	32 or lower	28 or lower	24 or lower	20 or lower	16 or lower
1951	2/11	3/26	3/27	4/23	4/23	10/20	11/3	11/3	11/3	11/3
1952	3/6	3/6	3/17	4/8	4/16	10/3	10/7	10/7	10/21	10/21
1953	3/10	3/10	3/10	4/19	4/21	10/8	10/30	11/10	12/15	12/15
1954	3/7	3/7	4/1	4/3	5/10	10/19	10/31	11/1	11/2	12/7
1955	3/28	3/28	3/29	4/8	4/9	10/25	10/25	11/4	11/18	11/28
1956	2/23	3/20	3/25	4/20	4/24	10/27	11/9	11/9	11/17	11/24
1957	-	-	4/9	4/15	5/5	10/11	10/11	10/20	11/10	11/10
1958	2/20	3/12	3/23	-	-	10/1	11/7	11/7	11/27	11/29
1959	3/18	3/22	3/23	3/29	3/29	10/12	10/18	11/7	11/8	11/17
1960	3/26	4/10	4/10	4/11	4/11	10/17	10/20	10/21	11/7	11/10
1961	2/9	2/26	4/2	4/16	5/27	10/15	10/27	10/27	11/7	12/13
1962	3/3	3/18	3/18	4/20	4/20	10/24	10/24	10/26	10/26	12/9
1963	3/3	3/3	3/22	5/1	5/23	9/30	10/30	11/15	11/15	12/4
1964	3/18	4/1	4/1	4/9	4/11	9/14	10/7	10/10	10/10	11/21

Physiography

About half of Morgan County (the northern and eastern parts of the county) lies within the Tipton Till Plain physiographic region of the state. The remainder occupies the Norman Upland with only a small area in the southwestern corner on the Mitchell Plain (Figures 4 and 5).

In respect to its physiographic situation in the United States, the northern and eastern parts of the county are within the Till Plain section of the Central Lowland province, and the south and western portions belongs to the Interior Low Plateaus province (7).

Topography

The topography of Morgan County is of great variety and complexity. Each of the physiographic regions has a characteristic land form that is related to geologic formation. Considerable variation from the typical land form occurs in each region as a result of glaciation and subsequent stream dissection.

The Norman Upland section is a stream dissected area with great local relief (See Figure 6). Drainage networks are deeply incised into the Borden sandstone and shale formation. Elevation generally ranges from 800 to 900 feet (254 to 275 m) above sea level with local relief from 100 to 200 feet (30 to 60 m) or more. The ridge tops generally are long, tortuous and narrow. The Norman Upland has a wall-like appearance from the east. The most prominant terrain feature occurs at Blue Bluffs along West Fork White River at section 10 and 11, T.12N., R.1E. The maximum local relief in Morgan County of about 280 feet (85.5 m) is located at Fox Cliff in section 10, T.12N., R.1E.

The northern part of the Norman Upland has been modified noticeably by the Illinoian glacier. Most of the higher knobs or ridges were leveled. The glacial till with a thickness from 25 to 100 feet (7.6 to 30.5 m) was deposited over the bedrock and around the hills. The ridge crests are nearly level with an elevation about 800 feet (244 m) above sea level. The prominent elevations in this region are a result of weakly glaciated sandstone ridges or knobs. This area has been thoroughly dissected and bedrock is exposed on nearly every hillside.

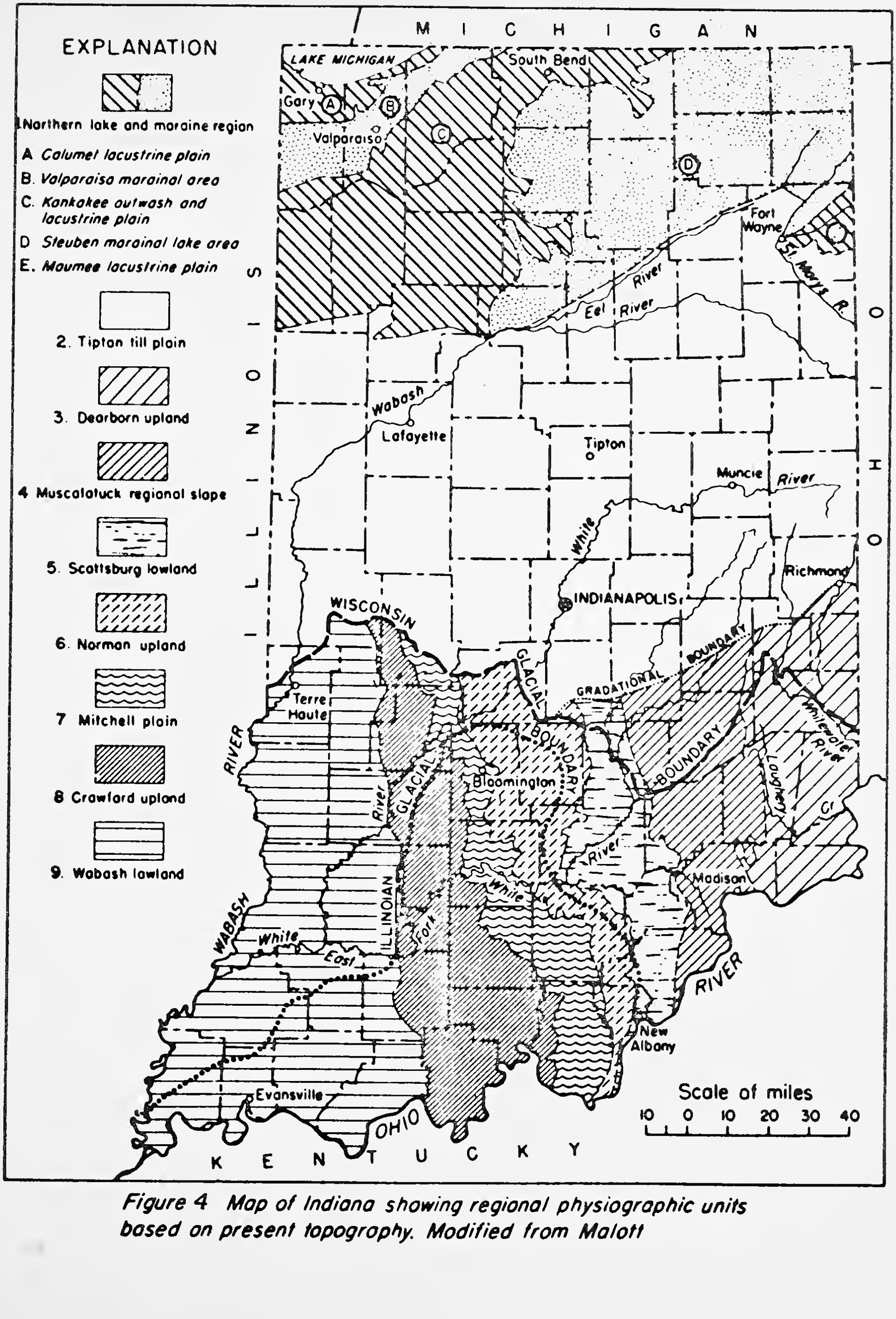


Figure 4 Map of Indiana showing regional physiographic units based on present topography. Modified from Malott

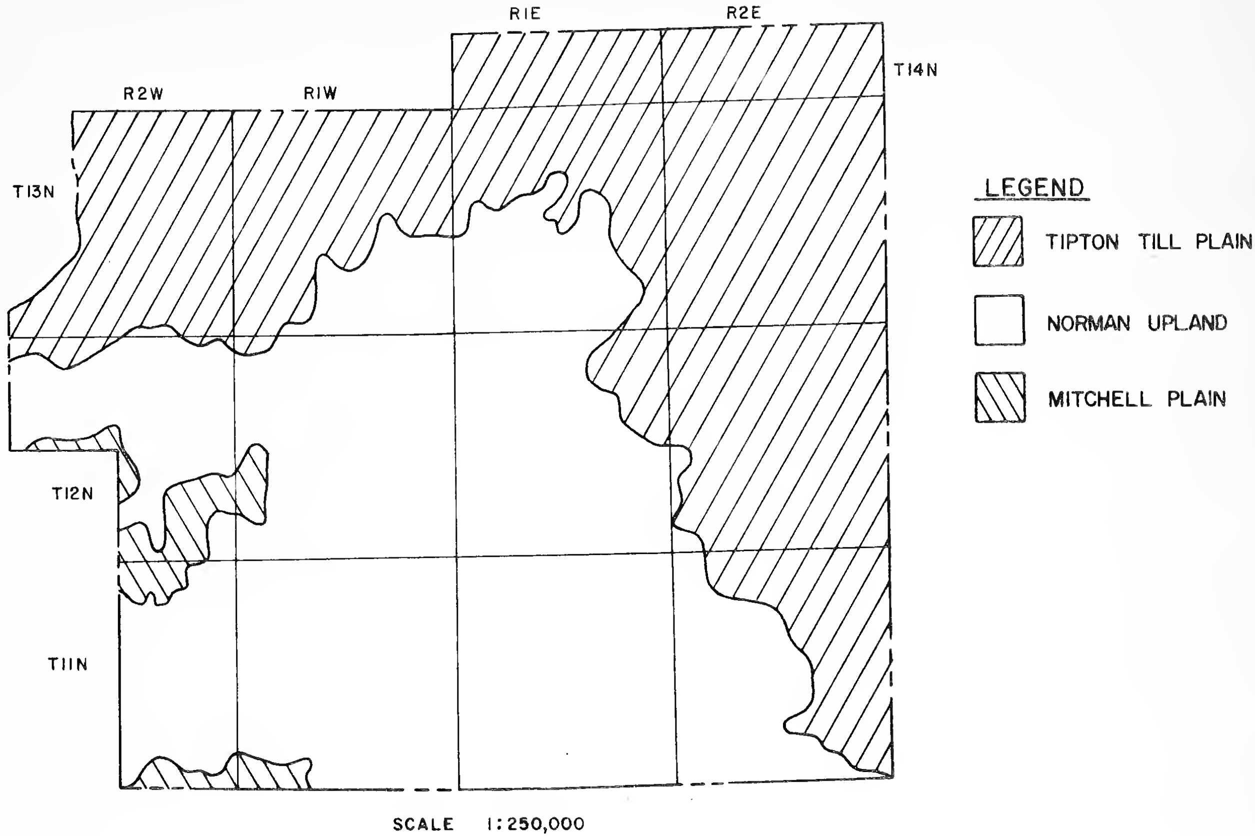


FIGURE 5 PHYSIOGRAPHIC DIVISION OF MORGAN COUNTY

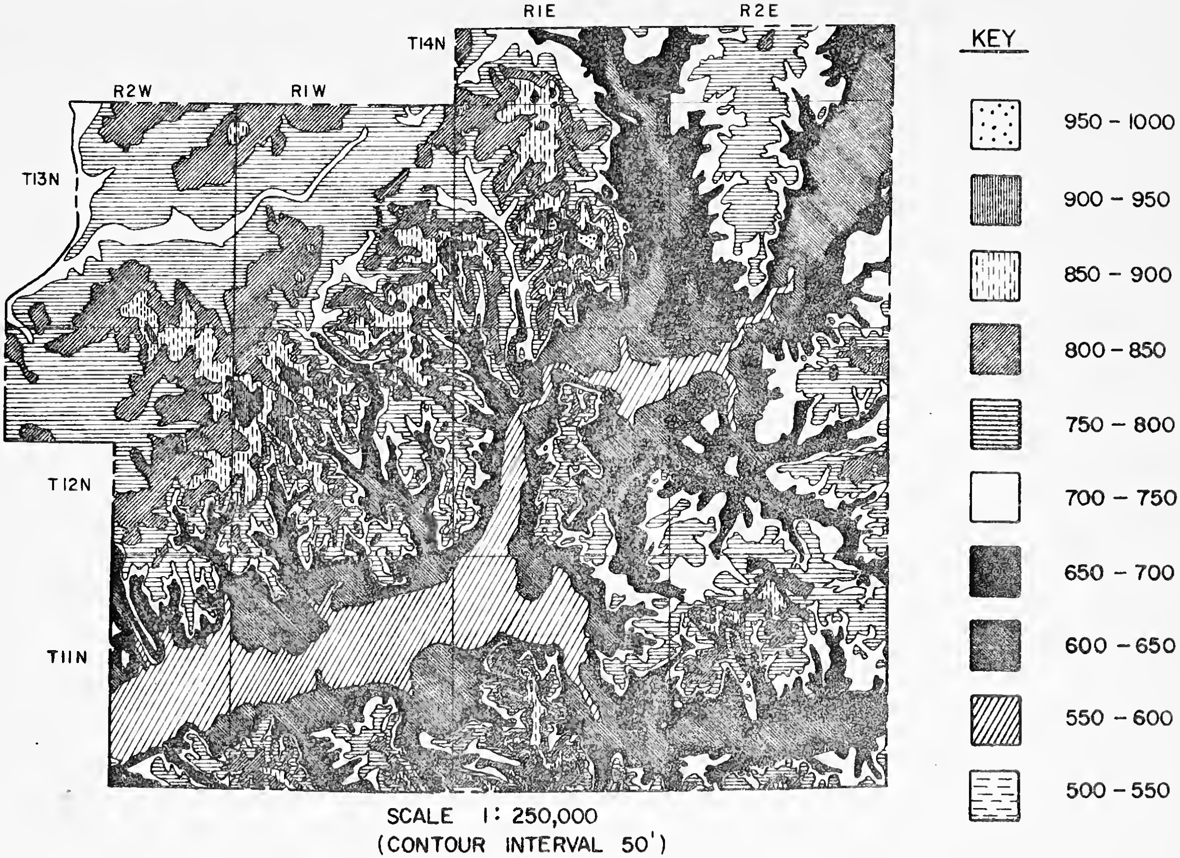


FIGURE 6 TOPOGRAPHIC MAP OF MORGAN COUNTY

The typical topographically flat Illinoian till plain occurs west of Wakeland. Local relief in this area is generally less than 20 feet (6.1 m). The valley walls have a gentle slope toward the aggraded bottoms. This flat land is about 20 feet (6.1 m) lower than the Mitchell plain to the south.

Northeast of Martinsville the area exhibits a kame morainal or pitted outwash topography. Many kettles or basins of various size are scattered throughout this region. The elevation of this plain ranges from 750 to 790 feet (229 to 241 m) about sea level. The kettles are 10 to 20 feet or more (3 to 6.1 m) below the surrounding land. Many of the kettles are ponded during the wet season.

Southeast of Matinsville there is a thoroughly dissected outwash plain. It has a remarkable plain-like topography. The attitude of the plain ranges from 750 to 762 feet (228 to 232 m) above sea level. A prominant sanddune topography can be observed just east of Martinsville. It is slightly higher in elevation than the outwash plain to the east and over 150 feet (46 m) above the huge terrace of West Fork White River.

The Mitchell Plain is represented by a few small areas in the western and southwestern parts of the county. The plain is formed by the capping of the Harrodsburg limestone over sandstone, siltstone and shale of the Borden formation. Typical sinkhole Karst topography exhibits in the areas north of West Fork White River. The undulating ridges are broken by numerous shallow sinkholes, 6 to 10 feet (2 to 3 m) deep. The area south of the river has fewer sinkholes and the smoother ridges are gently undulating. Near the valley of the West Fork White River where local relief is great, streams and gullies have dissected most of the plain and cut through the limestone into the underlying sandstone and shale. The Mitchell plain in Morgan County had been overridden by the Illinoian glacier and a thin deposit of drift overlies the limestone rock.

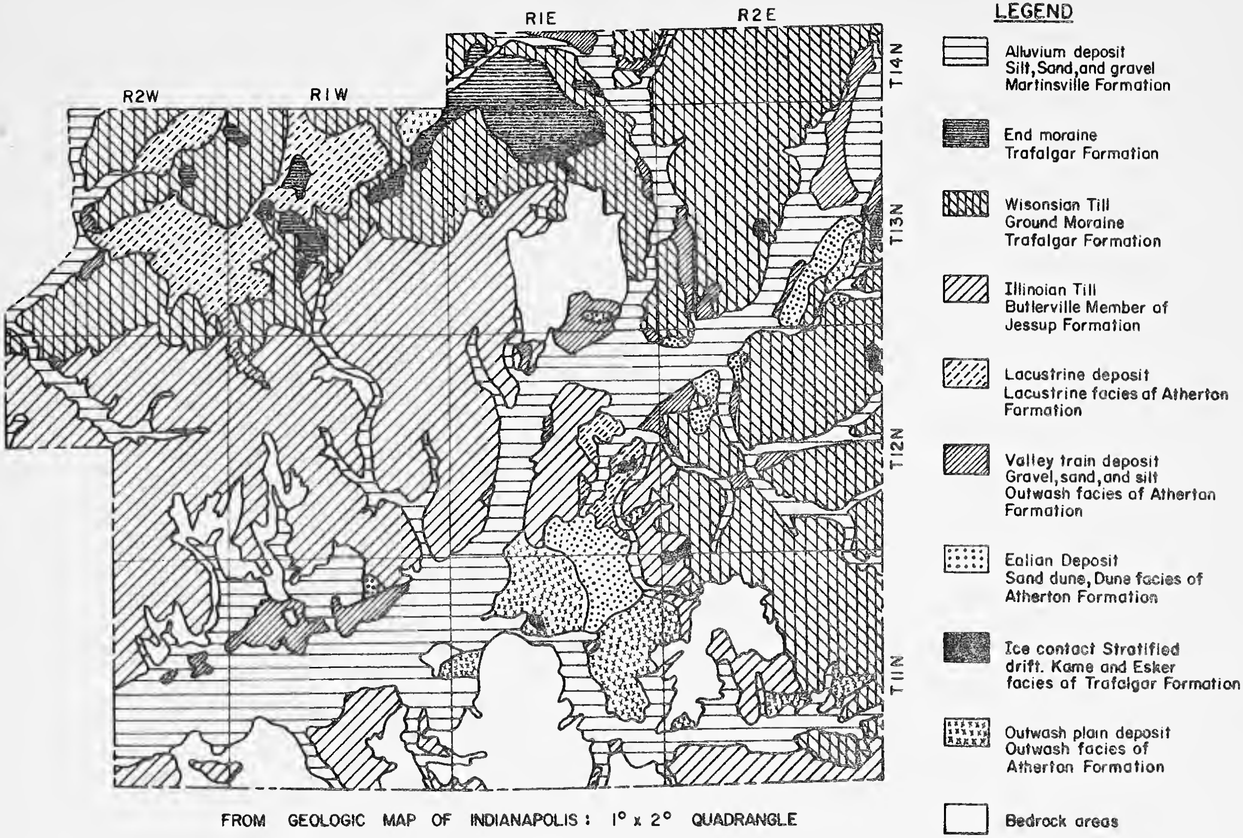
The northern part of the county is covered by the deposits of the Wisconsinan glacier which form the Till Plain Section. There are two substages of the Wisconsinan glaciation within the Till plain section of Morgan County. The early Wisconsinan drift covers the greater part of the Till plain section. Typical undulating till plain topography is found in the northwestern corner of the county. Former marsh areas or depressions are extensive in this section. Stream dissection is slight with local relief rarely exceeding 30 feet (10 m). A large lacustrine plain is located in this section. Relief ranging from 50 to 100 feet (15.3 to 30.5 m) is common on the eastern part of the region. The late Wisconsinan glaciation occupied the north central and northeastern corner of the county. The terminal is roughly marked by kames that rise 40 to 80 feet (12.2 to 24.4 m) above the surrounding till plain. The area is slightly dissected in the west and extensively dissected in the east with local relief ranging from 20 to 70 feet (6.1 to 21.4 m).

The most striking topographic feature in Morgan County is the West Fork White River which traverses the county from northeast to the southwest. It exhibits a wide and flat alluvial flood plain with low terraces. The alluvial flood plain and terrace plains along the White Lick Creek and Indian Creek are also prominent (See Figure 2 and Figure 6).

Geology

The surface and near surface materials represented in Morgan County are the unconsolidated material of the Quaternary period and the consolidated material of Palezoic age. The quaternary materials are both pleistocene and recent in age.

The general surface deposits of the county are shown in Figure 7. About one third of the surface deposits on the north and eastern portion of Morgan County are ground moraine of Wisconsinan age classified as the Trafalgar Formation by Wayne (8). The remnant of an end moraine is located in the northern part of the county. This end moraine is part of the Crawfordsville morainic system proposed by Wayne (9). Along the



FROM GEOLOGIC MAP OF INDIANAPOLIS: 1° x 2° QUADRANGLE

SCALE: 1 : 250,000

FIGURE 7 SURFACIAL GEOLOGIC MAP OF MORGAN COUNTY

Wisconsinan glacial borderin the southeastern section of Morgan County lies the remnant of the Shelbyville Moraine (10). Both end moraines are included in the Trafalgar Formation by Wayne.

The southwestern half of the county is covered by glacial till of Illinoian age classified as the Butlerville Till member of the Jessup Formation. A large area at the northwestern corner of the county is the lacustrine deposit of glacial Lake Eminence classified as the Lacustrine Facies of the Atherton Formation of Wisconsinan age.

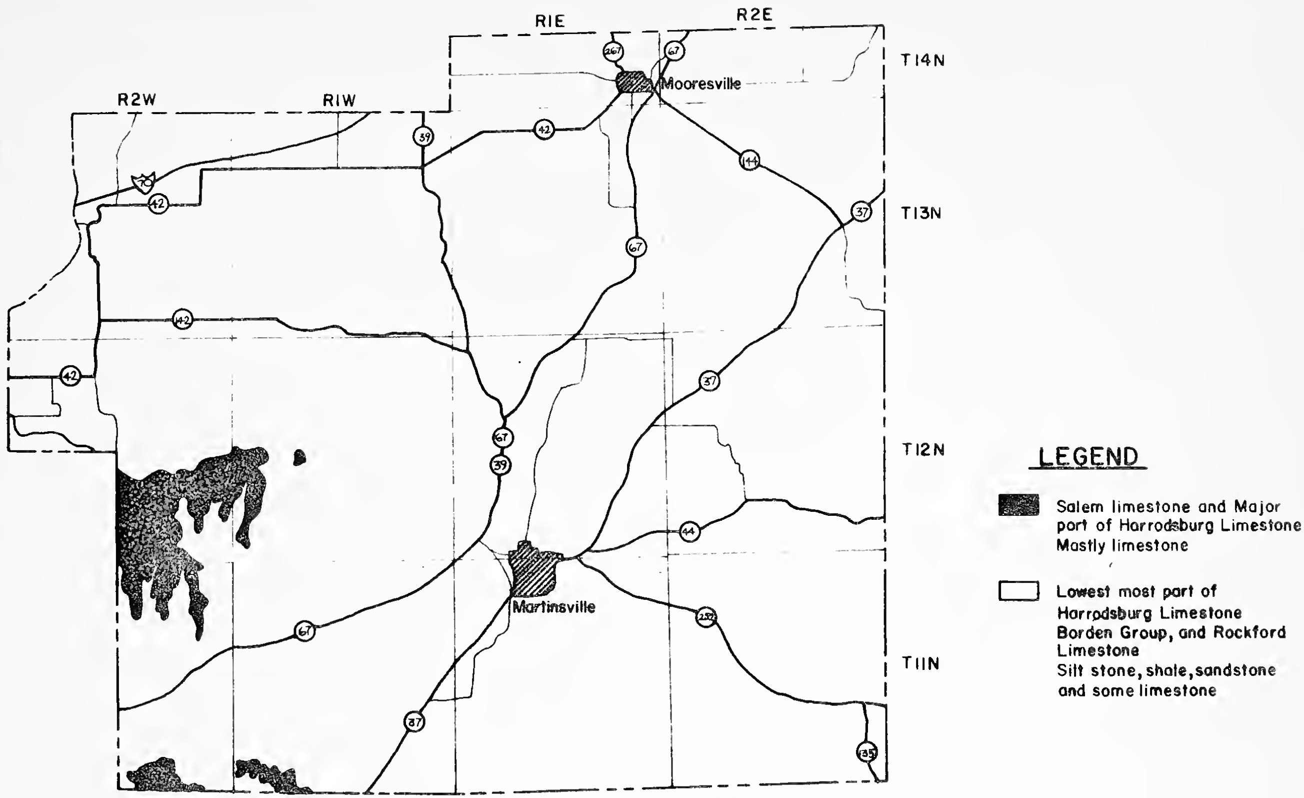
A considerable amount of alluvial deposits of the Martinsville Formation occur within the county (See Figure 7). Large outwash plains are located at northeast and southeast of Martinsville and some smaller ones are located at the north boundary and the northeastern section of the county. The deposits are classified as outwash facies of the Atherton Formation. Terrace or valley train deposits of the outwash facies of the Atherton Formation are found along the West Fork White River and its major tributary White Lick Creek.

Prominent sandy eolian deposits classified as Dune facies of the Atherton Formation are found just east of Martinsville and along the West Fork White River to the northeast.

Bedrock outcrop areas are found mostly on the southern half of the county. A sizable area, however, is located between Martinsville and Moorsville. The bedrock in this area is composed of siltstone, shale, sandstone and some limestone of the Borden Group of the Mississippian period.

The bedrock underneath the unconsolidated surface materials are of the Mississippian periods. Some small areas, at the southwestern corner of Morgan County, are underlain by the Harrodsburg limestone (see Figure 8) while most of the county is underlain by sandstones and shales of the Borden group.

Bedrock exposures are numerous at deep cuts along highways and railroads. Many drainage channels are entrenched into the bedrock particularly along the West Fork White River. The thickness of glacial drift and the rock outcrop area are indicated in Figure 9.



FROM GEOLOGIC MAP OF INDIANAPOLIS 1° x 2° QUADRANGLE
SCALE 1: 250,000

FIGURE 8: BEDROCK GEOLOGY OF MORGAN COUNTY

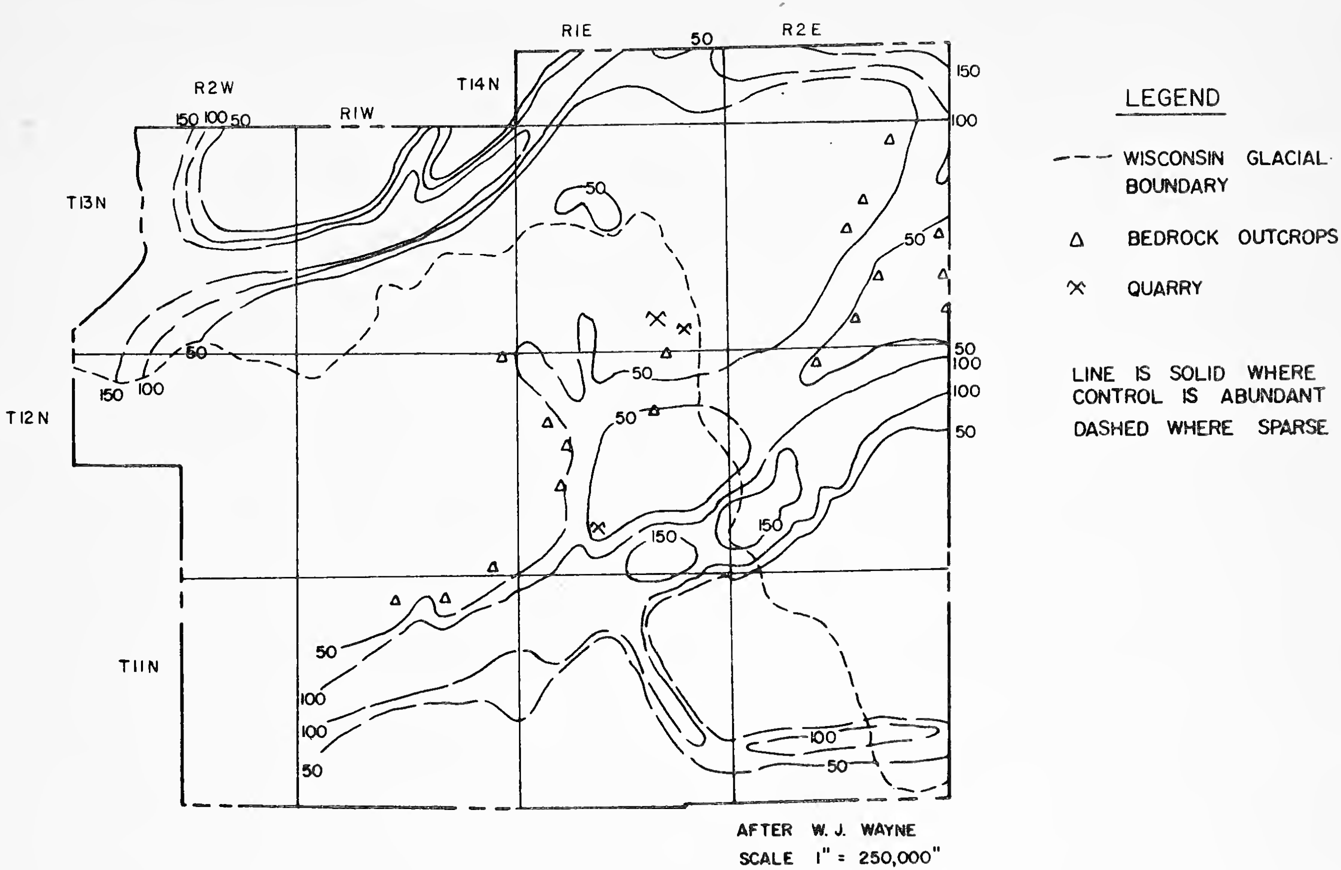


FIGURE 9 THICKNESS OF DRIFT AND BEDROCK IN MORGAN COUNTY

LAND FORM AND ENGINEERING SOIL AREAS

The engineering soils in Morgan County are derived both from unconsolidated and consolidated materials. The unconsolidated materials include glacial deposits, glacial fluvial deposits, alluvial deposits and eolian deposits. A small portion of the county is considered as a residual soil or non-soil area. However, due to the scale limitation of the attached map many narrow strip of rock outcrop along the valley wall of the major streams within the county cannot be shown.

The depostis of transported materials are not homogeneous and variation should be expected. General properties and profiles of the engineering soils for each area of different land form are presented in this report.

The entire county is covered by loess of various depth. The depth of the loess is thicker in the Illinoian glacial region and in the western part of the Wisconsinan glacial area. However, most of the loess mantle is less than six feet (1.8 m); it is not considered as a separate landform in this report.

Glacial Deposited Materials

Most of the soils of Morgan County are of glacial origin. The northwestern and southeastern portions of the county are covered by glacial deposit of the early Wisconsinan age classified as the Center Grove Till member of the Trafalgar Formation. The northeastern portion of the county is covered by the late Wisconsinan drift classified as the Cantersburg Till member of the Trafalgar Formation. The southwestern part of the county is covered by glacial drift of Illinoian age called the Butlerville Till member of the Jessup Formation.

Owing to the long period of weathering and erosion, the end or ridge moraine of the Illinoian age is no longer visible. In the Wisconsinan glacial region, however, the terminal moraine and kames can be recognized.

Many hills or knobs occur in the southern half of Morgan County. This is the area of thin glacial drift over sandstone and shale or limestone bedrock. The various landforms are discussed as follows:

1. <u>Ground Moraine of the Early Wisconsinan Age with Thin Loess Mantle</u>

Ground moraine deposits of the early Wisconsinan age have a loess mantle which varies from 18 to 40 inches (45 to 92 cm) in depth. The thickest loess cover is found at the northwestern corner of the county and decreases gradually to the east. Along the valley wall and gully areas the loess cover may be removed entirely by erosion. Most of the boundary with the Illinoian drift to the south has no conspicuous topographic distinction. However, the difference of airphoto patterns especially the drainage pattern between these two different drift deposits made the delineation possible. Gently undulating topography is predominate in this region. Slightly rugged areas are confined to the vicinity of stream channels.

The soil profiles developed in this region are characterized by a silty loam or silty clay loam (A-4 to A-6 soil) A-horizon, a silty loam to clay (A-7-6) B-horizon and a loam to clay loam (A-4) C-horizon. In the slightly lower topographic position or depression, the top layer of soil contains considerable amount of organic matter. A higher clay content in the B-horizon is expected.

Boring data along I-70 from sites #18 to #40 are most typical of this region. The top soil is a silty clay loam (A-4) soil and the B-horizon is a clay or silty clay (A-7-6) soil. The parent material is a loam or clay loam (A-4) soil. The top soil consists of 25% of sand, 53% of silt and 22% of clay as shown in the boring at site #19 in Appendix A. East of site #41 the top soil contains a little more sand (30%), a little less of silt (46%) and about the same amount of clay (23%), as illustrated in the data at site #43. This soil sample is identified as clay loam but remains in the same A-4 soil classification (See Appendix A).

Boring data along SR 67 shows a more irregular deposit. The area between site #140 and site #142 has a (A-4) to (A-6) top soil and shale is encountered about 10 feet (3 m) below the surface. A thick layer of sandy loam (A-1-b) is found along the bank of a channel at site #144. The profile at this

site shows that beneath the one foot (30 cm) of top soil lies 5.5 feet (1.67 m) of clay (A-6) and then 3.5 feet (1.07 m) of sandy loam (A-1-b) soil and five feet (1.5 m) of sand (A-1-a) further down. A sandy loam (A-4) layer was found further north at site #152 and #156.

High water table in the near level and depressional area and the low shearing strength of the somewhat plastic subsoil together with the high compresibility and frost heave are the engineering problems in this region.

2. Ground Moraine of the Late Wisconsinan Age

Ground moraine of the late Wisconsinan age is located along the northern part and northeastern corner of Morgan County. It has a very gently undulating to nearly flat topography. The boundary between the early and the late Wisconsinan drift is not very distinct because the parent material of both drifts are essentially the same and the late Wisconsinan drift is also covered by a very thin veneer of loess which varies from 0 to 18 inches (0 to 45 cm). Only the drainage pattern reveals the difference between these deposits.

Except for the top layer the soil of this region is derived from the loamy to clay loam glacial drift. The A-horizon varies from a silt loam to clay (A-6) soil. The B-horizon is a silty clay or clay (A-7-6) soil and the C-horizon is a loam or clay loam (A-4) soil.

Boring data along I-70 between site #51 and #58 show a clay loam (A-4) A-horizon. The soil consists of 29% of sand, 45% of silt and 26% of clay. Further east from site #67 to #74 the amount of loess decreases. The A-horizon contains 32% of sand, 34% of silt and 34% of clay and is classified as clay (A-6) soil. The B-horizon in this region is clay (A-7-6) soil. Clay (A-6) and clay loam (A-4) are found in the parent material. Layers of sandy loam (A-4) are found in the parent material. Layers of sandy loam (A-4) and sand (A-1-b) are found at sites #52, #53 and #56 from 3.8 feet (1.06 m) to 8 feet (2.44 m) below the surface. No sandy deposits are found between sites #67 and #74.

Sandier texture may occur near drainage channels as recorded in the boring data along SR 144 at Section 5, T.13N.,R.2E.(11). Sandy loam and sandy clay loam (A-4 soil) are common in that area.

Problems including drainage, frost action, pumping and poor subgrade strength may occur in the plastic B-horizon.

3. Ridge Moraine of Wisconsinan Age with Thin Loess Mantle

Ridge moraines of Wisconsinan age are scattered along the northern and eastern part of Morgan County. Most of them are isolated or segmented along the distal edge of the late and early Wisconsinan drifts. One occurs near the north central part of the county just southwest of Moorsville. This moraine belongs to the Crawfordsville Moraine suggested by Wayne (9). Those located in the southeastern portion of the county belong to the Shelbyville Moraine.

The ridge moraine is much higher in elevation than the surrounding ground moraine. The altitude of the moraine ranges from 750 feet (228 m) to 830 feet (283 m) above sea level. Most of the moraine is above 800 feet (244 m) in elevation. Hummocky to rolling topography predominate in this region.

A few isolated elongate ridges are found north of Morgantown. These ridges are slightly higher than its surrounding till plain. They are the segmented Shelbyville moraine located along the distal edge of Wisconsinan drift (10). The ridges also have an hummocky to gently rolling topography.

Soils in the ridge morainic area are more erratic. The surface soil varies from loam to silty clay loam. Sandy clay loam to clay is generally found in the B-horizon. The C-horizon ranges from sandy loam to clay. In the low topographic position or in the depressions organic silty clay loam to organic clay top soil may be expected. Boring records along I-70 from sites #28 to #33 show that the A-horizon is either a silty clay loam (A-4) or a clay loam (A-6). The B-horizon is a clay or silty clay (A-7-6) soil. Clay loam or loam (A-4) soil is found in the C-horizon.

Between boring sites #59 and #61 the top soils and the B-horizon are about the same as those in #28 to #33. However,

the C-horizon is silty clay or clay (A-6) soil. Sand (A-2-4) soil was found between sites #60 and #61 at a depth of 10.7 feet (3.26 m) from the surface.

Many small kames can be identified within the ridge morainic region. Coarser texture may be expected in them.

Due to the hummocky or rolling topography cut and fill become a problem. The variable strength of the subsoil when changes from a coarser to a finer deposit may create problems.

4. <u>Ground Moraine of Illinoian Age with Thin Loess Mantle</u>

About one fifth of Morgan County is covered by the ground moraine of Illinoian age. The main body of the deposit is located at the west central portion of the county. Smaller areas are scattered in the southern quarter of the county. The drift deposit is overlain by a thin loess (less than six feet or 1.8 m). The loess is thicker at the western portion of the region and decreases in magnitude toward the east. In the sloping area where erosion is severe the loess mantle may be lost.

The topography of this ground moraine varies from nearly level to gently undulating. At the highly dissected area a rolling topography may be present. Gullies along the major streams are deeply incised into the upland giving the area a rugged look. Many areas are still under timber cover, especially along the steep valley walls of the streams. The most typical Illinoian ground moraine occurs in the western portion of the region where a relative flat topography can be observed. The rest of the region is under the influence of the underlying bedrock since the thickness of the drift is less than 30 feet (10 m) in depth (figure 9). The well developed white fringe along the dark centered gullies is the typical airphoto pattern of this deposit.

The upper horizon of the solum is derived from the loess material. The thickness of the loess cover depends greatly on the topography position and the distance from the river. The greater the distance the thinner the loess deposit. On steep slopes where erosion is severe, the loess mantle may have been removed.

The soil profile shows that the A-horizon is a silt loam or silty clay loam (A-4 soil). Silty clay or clay (A-6 or A-7-6 soil) is encountered in the B-horizon. A leached parent material is found with a texture from a loam to clay (A-6 soil). Local variation due to topography and the influence of bedrock should be expected in the gully area where loess mantle is lost and bedrock is close to the surface as illustrated in the boring data along I-70 (12). A coarser texture such as silty clay loam, sandy clay loam or sandy loam soil may be found on the gully wall. Boring sites #88, #97 and #98 along SR 67 are located near the edge of the valley wall may have the same special local effect.

Engineering problems associated with this soil area are those of low strength when wet, difficulty of compaction, drainage and erosion of side slopes. Along the valley wall in the dissected area cuts may encounter different types of sedimentary rock.

5. Thin Illinoian Drift over Limestone

The thin Illinoian drift over limestone areas are scattered in the west - central part and near the western border of the county. The total area of this deposit is about five square miles (13 sq. km). The deposit is generally slightly higher than the surrounding ground moraine deposit and has a gently undulating, sinkhole studded topography. The sinkholes are variable in size, depth (from six to ten feet - 1.8 to 3.0 m) and also in denisty. With its typical sinkhole pattern, the area is easy to delineate.

The soil of this area is developed in 10 to 50 inches (25 to 127 cm) of loess over weathered Illinoian till which is underlain by material weathered from limestone. Depth of bedrock ranges from 3 to 8 feet (1 to 2.4 m).

The soil profile of this area consists of a silt loam topsoil and a clayey subsurface soil. On steep slopes where erosion is severe the silt loam topsoil may be removed and the

clayey subsurface soil exposed. This subsurface soil is underlain by silty clay and then silt loam derived from the Illinoian drift. A layer of red clay is encountered before the unweathered limestone bedrock is reached. This layer of highly plastic clay is the result of the weathering of the limestone.

At the bottom of the sinkhole, the soil is derived from sheetwash material. Underneath the silt loam to silty clay loam topsoil is a sandy clay loam or silty clay may be encountered. A layer of clay is usually encountered before reaching the limestone bedrock.

Cut and fill of the irregular rock surface, sinkhole pluging and/or fill stability are the problems generally found in this area.

6. Thin Illinoian Drift over Interbedded Sandstone-Shale

The thin Illinoian drift over interbedded sandstone and shale areas are confined in the Illinoian drift region on the western half of Morgan County. These soils are located along the valley walls of the major tributaries of the West Fork White River and also between the sandstone shale residual soil along the valley wall and the Illinoian ground moraine upland. The soil areas are very narrow and most areas cannot be mapped at the small scale of the soil map. Several ridges and hills, however, are outlined on the map.

The soil in this area is developed from a blanket of loess, less than 48 inches (122 cm) in thickness, underlain by weathered Illinoian drift and sandstone-shale. The upper soil profile is essentially the same as the soil of the loess covered ground moraine of the Illinoian age. However, the silt loam or silty clay loam topsoil may be absent on steep slopes. The B-horizon consists of silty clay to clay soil. Clay loam and clayey soil form the C-horizon. Generally a layer of sandy clay loam or silty clay with rock fragment may be found overlying the interbedded sandstone-shale. This is the residual soil of the

sandstone-shale underlying the glacial material. In the more level areas sandstone-shale bedrock lies less than 10 feet (3 m) from the surface. On the slope bedrock usually is less than seven feet (2 m) from the ground surface.

Problems in this area are those of seepage, compaction control and erosion of side slopes. Sandstone-shale bedrock may be encountered in shallow cuts.

7. Kames and Eskers

A number of kames are recognized in Morgan County. Most of them are located in the northern third of the county. Some of them that rise 40 to 80 feet (12 to 24 m) above the surrounding till plain may be considered as remnant of the ridge moraine. Inside the ridge morainic area there are many kames. Groups of kames are outline with a dotted line within the region. Several small kames can be identified northeast of Martinsville. However, only one esker is recognized in Morgan County. It is located adjacent to Clear Creek in the southeastern corner of Secion 19, T.12N., R.2E. The esker is about one quarter of a mile (0.4 km) in length and has a relatively straight course.

Most of the small isolated kames and eskers remain as wooded lands because of their steep topography. However, on the kame groups or the ice contact deposits, the surface is undulating and cultivation is possible. Many gravel pits are located in these deposits. Two pits may be observed on the esker in the 1938 airphotos.

The soils developed on eskers and kames vary considerably. Due to the thin loess mantle and the degree of erosion, the A-horizon varies greatly in both texture and in thickness. Soil classsified as loam, clay loam, silt loam and silty clay loam may be found. In areas of severe erosion, the surface soil may be entirely gone and the subsoil exposed. The B-horizon varies from clay loam to clay with varying amounts of sands and gravel for different deposits. The amount of sand and gravel increases generally very rapidly with depth. Clean

stratified sands and gravels are found in the parent material zone. This stratified coarse material disappears rapidly from the base of the esker and kame and merges with the glacial till in the surrounding areas.

No engineering problems are expected in this deposit. In fact it is potentially a good source of construction material.

Fluvial Deposit Materials

More than one third of Morgan County is covered by fluvial deposited materials. Four different land forms created by the action of water, namely outwash plain, terrace, lacustrine plain and alluvial plain are discussed as follows:

1. Outwash Plains

Due to different texture and origin, outwash plains are subdivided into three groups namely: coarse textured, sandy textured and fine textured outwash plains. They are discussed in detail as follows:

(A) Coarse Textured Outwash Plains

The coarse textured outwash plain is generally associated with the Wisconsinan glacial period. However the one located northeast of Martinsville may be considered as a coarse textured outwash plain within the Illinoian drift territory. The surface of this area has a pitted outwash plain appearance. And the basins or kettles are somewhat aligned in a southwesterly direction. Part of the outwash plain is overlain by eolian sand. However the western end of the plain is exposed and a number of gravel pits were identified in the 1938 airphotos.

The coarse textured outwash plain in the Wisconsinan drift territory are located along the northern border adjacent to Hendricks County. The larger one is located along the upper reach of White Lick Creek west of Mooresville. The rest are located near the northeastern corner and near the eastern border of the county just south of Waverly. Only the later one has a typical granular outwash plain airphoto pattern where infiltration basins, which characterized this kind of deposit,

appear. The other outwash plains west of Mooresville have a flat topography and is topographically lower than the surrounding drift. Surface drainage is absent without infiltration basins.

The soil profile of the coarse outwash plain consists of a sandy loam to silty clay loam topsoil underlain by a gravelly clay loam to sandy clay loam and than the stratified sand and gravel parent material.

No boring data is available for this deposit. However, from the water resources study of Morgan County, the area northeast of Martinsville which was mapped as outwash area shows a thick deposit of outwash sand ranging from 100 to 275 feet (30.5 to 84 m) in depth (13).

Few engineering problems are expected in this deposit.

(B) Sandy Textured Outwash Plains

The sandy textured outwash plain is mainly located northeast of Martinsville and along the west bank of Burnetts Creek, west of Martinsville. Several smaller deposits are located in the Wisconsinan drift region. One lies north of Monrovia, the others are located just west of Mooresville at the northwestern corner and east of Brooklyn. Several island like small areas occur amid the large lacustrine plain in the northwest quarter.

The outwash plain located west of Brooklyn is essentially a deposit in a glacial sluice way of the White Lick Creek. The one just west of Mooresville may be considered as a lacustrine deposit when the outlet to the White Lick Creek to the southeast was blocked. The sandy outwash deposit at and near the mouth of Clear Creek northeast of Martinsville is topographically lower than the outwash plain on the south (710 to 730 feet or 216 to 222 m in elevation from sea level against 770 feet or 235 m on the high outwash plain to the south). This may also be considered as lacustrine deposit also as mapped in the surfacial geological map in Figure 7. Since these three deposits essentially are derived from sandy textured outwash materials they are considered under the same category. However, a dotted line is used to separate the high and low plains.

The sandy textured outwash plain generally has a flat to gently undulating topography. However, highly dissected topogrphy exists in the areas within the Illinoian territory because they were subjected to a longer weathering period.

The soil is derived from a thin loess cover (0 to 40 inches or 0 to 1 m). The surface soil varies from a loam to a silty clay loam. In the areas where the natural form of deposit may be considered as lacustrine, the surface soil is more clayey in texture. The B-horizon varies from a sandy clay loam to a clay soil. A sandy loam or sandy clay loam soil may be encountered before the stratified sand parent material is reached. Some gravel layer may be present from place to place.

There should be limited engineering problems in this area except the cut and fill requirements in the Illinoian drift territory.

(C) <u>Fine Textured Outwash Plains</u>

The fine textured outwash plain is confined to an area about seven square miles (18 square km) southeast of Mantinsville. This is an Illinoian outwash plain. It has a nearly level surface (elevation about 750 to 760 feet or 229 to 232 m above sea level). Due to its old geological age and the low base level of the drainage of the area (about 150 feet or 46 m different in elevation) the headward erosion creates a very rugged land form in the area. The flat areas are intensively cultivated but the gully or valley walls are suitable only for wooded land. Severe gully erosion occurs when forest cover is not maintained.

The soil is developed under a loess blanket of 42 to 60 inches (1.0 to 1.5 m) in thickness. The soil profile shows a loam to a silty clay loam topsoil followed by silt loam to clay subsurface soil and this is underlain by a sandy clay loam to silty clay loam. The stratified silt and fine sand with occasional fine gravel and thin layer of clay is found generally at a depth of 6 to 12 feet (1.8 to 3.6 m) from the surface. Due to the long weathering period the calcareous material in the parent deposit has been leached down to a depth of 15 feet

(4.5 m). In the slightly depressed areas the soil contains more clay in its surface and subsurface soil and the parent material of stratified sand, sandy loam and sandy clay is below a depth of 12 to 20 feet (3.6 to 6.0 m).

Erosion protection seems to be the problem that engineers have to overcome. Considerable earth work may occur if highway locations cut across the valley.

2. Terraces

Three types of terraces occur in Morgan County. They are the coarse textured terrace, sandy textured terrace and the slack water terrace. The detail of each is discussed as follows:

(A) Coarse Textured Terraces

Most of the coarse textured terraces are found along the West Fork White River and along White Lick Creek.

Current scars and infiltration basins, the typical air-photo patterns for coarse textured terraces, can be observed from the photographs. All of the terraces are low terraces. They are about ten feet (3 m) higher than the adjacent flood plain.

The soil profile of the coarse textured terrace consists of a gravelly loam to a silty clay loam topsoil, a gravelly clay loam or gravelly silty clay loam subsoil and stratified gravel and sand parent material. Gravel usually is found three to four feet (1 to 1.3 m) from the surface.

Boring data along SR 37 from sites #159 to #164 show that the top strata varies from a loam to clay loam (A-4) soil to sandy loam to sand (A-2-4). The substrata however are coarser in texture. Sandy loam or sand (A-2-4) to gravelly sand (A-1-b) are the prevailing texture of the deposit.

In general few engineering problems are expected in this landform. In fact, the deposit is a good material source for construction as demonstrated by the number of gravel pits near Waverly.

(B) Sandy Textured Terraces

The sandy textured terraces in Morgan County occur also along the West Fork White River and the major streams on the

northern half of the county. The largest deposit is located near the confluence of Indian Creek and West Fork White River where Martinsville is built. The other sizable terraces lie further down stream from Martinsville to Paragon.

The sandy texture terraces are extremely flat and are slightly higher(less than 10 ft. or 3 m) than the adjacent flood plain. Infiltration basins occur occasionally, but current scars are absent in this deposits. Surface drainage is absent also.

The soils at the sandy textured terrace are developed on stratified silt and sand with small amounts of fine gravel and clay strata. The surface soil varies from a sandy loam to silty clay loam. The subsoil is graded from a gravelly clay loam toward sandy loam before stratified material is reached. At the slightly low topography the subsoil is mainly silty clay or clay.

Since the deposit is only slightly higher than the adjacent flood plain, high water table, poor drainage condition and ponding during high water are problems.

(C) <u>Fine Textured or Slack Water Terraces</u>

The fine textured terraces and the slack water terraces are essentially the same in texture. The fine texture terraces are usually confined to the stream in Illinoian and sandstone-shale region. The slackwater terraces, however, are found mostly along Indian Creek. It is also probable that the terraces in the tributories of the West Fork White River within the Illinoian and and sandstone-shale region were deposited in slow moving water during the glacial period because of back water from the river. Henceforth, all the terraces in that region are mapped as slack water terraces.

The slack water terraces are extremely flat and only slightly higher than the adjacent flood plain. The topographic break between the flood plain and this terrace deposit is inconspicuous. Infiltration basins and current scars are missing in these terraces. Surface drainage is poorly developed.

The soil of the slack water terrace are developed from stratified silts, clays and fine sand. In the sandstone-shale and Illinoian drift area, the surface soil is mixed with alluvium washed in from the upland. In places an alluvial fan may be formed.

The soil profile on this deposit consists of a silt loam to a clay topsoil, a sandy clay loam to clay subsurface soil, a silt loam to silty clay subsoil and the stratified silts and clays and some fine sand may be found deep in the profile.

Boring data along SR 67 from sites #122 to #125 and #127 to #128 are entirely in this region. The top strata (2 to 3 feet or .6 to 1 m) of the soil from sites #122 to #125 shows a silt loam (A-4) soil overlying mostly a silty clay (A-6) substrata. The area closer to the upland, as in sites #127 and #128, shows more clayey in texture. The upper strata from a depth of six to seven feet (1.8 to 2.1 m) is a silty clay (A-6) soil. Further north at sites #135 and #136 located on a narrow terrace, the influence of bedrock may be noticed. Beneath the surface soil lies a clay to clay loam (A-6) soil two to three feet (0.6 to 1 m) in thickness. A sandy loam layer which contains more gravel and sand from 2.5 to 4.5 feet (.76 to 1.37 m) in depth was encountered. The soil is still classified as (A-6) by the AASHTO classification. A 5.5 feet (1.78 m) of silty clay loam (A-6) lies under the sandy loam at site #135 before the weathered shale bedrock is reached. At site #134, located on the edge of the sandstone-shale region shale is encountered at a depth of 2.5 feet (0.76 m).

The major problems associated with this area are the high water table and occasional overflow.

3. <u>Lacustrine Plains</u>

About 15 squre miles (39 sq. km) on the northwestern quarter of Morgan County are mapped as lacustrine plains. The largest area located within the Wisconsinan drift border is the deposit of glacial Lake Eminence. The smaller areas along the western border belong to glacial Lake Quincy which extented into the county from Owen County.

The topography of the lacustrine plain is a nearly level plain with an elevation from 745 to 760 feet (227 to 232 m) above sea level. Most of the plain in the north are void of surface drainage. However, ditches are extensively dredged to facilitate runoff. Natural drainage ways are well established in the smaller areas where the deposits were derived from the Illinoian glacial Lake Quincy.

Soil of these lacustrine plains are developed from a blanket of loess material, ranging from 10 to 40 inches (25 to 100 cm) in thickness and the underlying stratified lacustrine deposit. The topsoil of this area varies from a silt loam to clay. The subsurface soil is silty clay to clay in texture. A clay loam layer may be encountered before reaching the parent material. The lacustrine deposit varies from place to place. Silt, clay with some fine sand lenses are the prominant textures of the deposit.

Boring data along I-70 from sites #62 to #65 are located within the lacustrine plain. The topsoil is a silty clay loam (A-4) soil on the high topographic sites of #62 and #63. It changes to clay (A-6) soil toward the east. The B-horizon is a plastic clay (A-7-6) soil ranging from 2.2 to 4.0 feet (67 to 122 cm) in thickness. A layer of sand (A-2-4) ranging from 0.3 to 2.3 feet (9 to 70 cm) were encountered further down the profile. The material further down varies from clay (A-7-5) to silty clay loam (A-6).

Because of the poorly drained situation in some areas, frost heave, settlement and weak supporting power of the soils are the major problem in this deposit.

4. Alluvial Plains or Flood Plains

All drainage channels in Morgan County possess recent alluvial plains or flood plains. However, the extent of mapping of these plains was determined by the scale of the engineering soils map. The alluvial plains alone occupy about one quarter of the area of Morgan County. The texture of the alluvial plain is far from uniform from place to place. However, they can

be subdivided into two groups according to their prevailing texture namely: the coarse-textured alluvial plains and the fine-textured alluvial plains. They are discussed more in detail as follows:

(A) Coarse Textured Alluvial Plains

About 70 percent of the alluvial plains can be classified as coarse textured alluvial plains. The main body of this deposit is along West Fork White River. Others are along Mill Creek, Indian Creek, White Lick Creek and tributories inside the Wisconsinan drift region.

The width of the alluvial plain of West Fork White River varies greatly from less than a quarter of a mile (400 m) near Waverly to about three miles (4.8 km) near Paragon. Same is true for Indian Creek where the narrow place is less than 0.05 mile (80 m) and the wide spot is more than 1.2 miles (4.8 km) in width.

Most of the alluvial plains have flat to nearly level surface. Natural levees are developed along a portion of the larger streams. Special features such as current markings, meandering stream channels, oxbows and abondoned channels are plentiful along the major streams especially along West Fork White River in Morgan County.

The texture of the alluvial deposits varies greatly both horizonally and vertically from one place to the other. Coarser textured deposits are found adjacent to the main channel especially on the natural levees, loamy textured soil occurs near the main channel while silt loam becomes more prominent toward the valley walls. Silty clay loam soil are concentrated in old swales and depressions near the valley wall.

The variability of the soil is shown in the soil profile of the coarse textured alluvial plain. The surface soil ranges from sandy loam to loam, silt loam and silty clay loam. The subsurface soils are also extremely variable. Sandy loam, silty clay loam, silty clay or clay may be encountered. The material usually becomes more coarser with increases of depth. Stratified sand and gravel generally is found in areas close to the main channels, whereas in other areas stratified loam, fine

sandy loam and silt loam are most common. Detail field exploration is required in these regions.

The alluvial soil actually has little profile development other than the annual accumulation of flood materials. The granular texture of the deposit is illustrated by the gravel pits located in the vicinity of Martinsville along West Fork White River and near Mooresville along White Lick Creek.

Boring data along SR 67 reveal the variability of the texture of the alluvial deposits. The more typical texture of the deposit is found along SR 37 from sites #165 to #169 and #176 to #179. At site #165 the profile shows three feet (1 m) of sandy loam (A-2-4 soil) over three feet (1 m) of loam (A-4 soil). At site #166 the first two feet (60 cm) is a loam (A-4 soil) and is followed by four feet (1.2 m) of sandy clay loam (A-6). At the other sites silty clay loam, silty clay (A-7-6) were also found with strata of loam (A-6) and sandy gravel (A-1-a).

Boring along SR 67 are close to the Illinoian and sandstone-shale upland and the profile is more erratic. The typical coarse textured deposit is found between sites #119 to #121 where sandy loam (A-6) soil (ranging from 1.4 to 5.0 feet or 0.4 to 1.5 m in thickness) is found underlain silty clay loam (A-4) topsoil (0.3 to 0.6 feet or 9 to 18 cm in depth). Sand (A-2-4) strata follows further down the profile. Boring sites from #106 to #118 which were close to the upland shows that the silty clay loam or clay loam (A-6) to sandy loam or loam (A-4) subsurface layer is underlain by loam or silt loam (A-4 soil), sandy loam or sand (A-2-4 soil) and clay loam (A-4) or silty clay loam (A-6) soil.

Boring sites #75 to #77 shows that coarse texture material may be found deep in the profile. The profile at site #76 shows that a six feet (1.8 m) of silty clay loam (A-6) is followed by 5.5 feet (1.7 m) of very loose loam (A-4) and then a 2.5 feet (76 cm) of organic silty loam (A-4) and a seven feet (2.1 m) of silty clay with some organic matter (A-7-6) before more than 8.5 feet (2.6 m) of loose sand (A-1-b) soil is encountered. The soil profiles are complex.

Boring sites #'s 7, 8 and 9 along I-70 has a silty clay loam (A-4) to sandy loam (A-4) surface soil and silty clay to clay (A-6) subsurface soil (1.2 feet or 37 cm thick) and a sandy clay loam (A-4) soil or a clay (A-6) soil 2.5 feet (77 cm) in thickness. The soil underneath is a clay loam (A-4 to A-6) to clay (A-6). The finer texture may be attributed to the lacustrine deposit in the vicinity.

Flooding is the major problem in this area. Subgrade support is poor during wet seasons especially within the depressions.

(B) Fine-Textured Alluvial Plains

About 30 percent of the alluvial plains in Morgan County belong to the fine textured classification. All of them are confined within the Illinoian drift and the sandstone-shale bedrock region.

The alluvial plains are narrow and have a steep gradient near the headwater. They increase in width but decrease in gradient downstream. Current markings are void except at the lower reaches of the streams where considerable flow occurred. Other special features characteristic of flood plain in larger streams are missing in this area.

The soil of the fine-textured alluvial plains is more uniform than the coarse-textured alluvial plains. However, variation still exists from one place to the other. The surface soil varies from a gravelly loam to a silt loam. The subsurface soil ranges from a sandy loam to a silty clay. Stratified deposits further down the profile consists of either sandy clay loam, sandy loam or silt loam, silt and clay. Occasionally lenses of gravel may be encountered in the stratified sandy clay loam and sandy loam deposit.

Boring data along SR 67 at sites #85 and #87 may be considered as fine-textured alluvial plain deposit because they are located at the north of the drainage channel leading from Illinoian drift and sandstone-shale upland. At site #85 the profile shows the following sequence 0.5 feet (15 cm) topsoil, 2.5 feet (76 cm) silty loam (A-4), 1.2 feet (36 cm) of silt loam

(A-6), 2.3 feet (70 cm) of silty clay loam (A-6), 1.7 feet (52 cm) of silty loam (A-6), 1.8 feet (55 cm) of silty clay loam (A-6), 5.0 feet (1.5 m) of silt loam (A-6) on shale.

At site #87 a coarser deposit is revealed. The profile shows the following sequence: 4 feet (1.2 m) of silt loam (A-6), 2 feet (61 cm) of loam (A-4), 4 feet (1.2 m) of sandy loam (A-4), 5.5 feet (1.7 m) of loam (A-4) on a sandy loam (A-2-4).

The problems in this area are similar to those in the coarse textured alluvial plains with subgrade support being more critical.

Eolian Deposited Materials

Extensive eolian deposits occur in Morgan County. They are subdivided into two groups namely: loess mantle deposits and sand dune deposits.

1. Loess Mantle Deposits

About 80 percent of Morgan County is covered by a thin mantle of loess. As mentioned previously, the mantle varies in depth from nothing to about six feet (2 m). Since the blanket is rather uniform and comparatively thin, only the top part of the soil profile is subject to its influence. The discussion of the soils of this loess mantle is not treated separately but has been included with the other landforms previously discussed.

2. Sand Dunes

Considerable area in Morgan County is mapped as sand dune deposits. They are confined to bluffs along West Fork White River and Mill Creek. The largest sand dune deposit, about three square miles (7.7 sq. km) in size, is located just northeast of Martinsville. Another large deposit is located southwest of Waverly.

The sand dunes in Morgan County are irregular in shape and exhibit softly rolling to hilly topography. Hummocky landscape may appear in places. The topography of the sand dune is influenced greatly by the underlying material. In the deposit just east of Martinsville where outwash plain is mapped to the east, the sand dune is deposited over the outwash plain. Many infiltration basins appear in this area. Surface drainage is generally absent in sand dune deposit. However, surface drain-

age gullies developed when the sand deposit is thin as shown in some of the areas southwest of Waverly.

Soils developed in this area are derived from windblown sands and in places are mixed with windblown silts. The deposit ranges from 5 to 20 feet (1.5 to 6 m) in thickness. The surface soil varies from a loam, fine sandy loam to sand at the high position and to a silty loam in a low position. The B-horizon may vary from a sandy clay loam to a clay. Before the parent windblown sand is reached at a shallow depth a sandy loam, silt loam or silty clay loam layer may be encountered.

Boring data along SR 67 at site #126 is located on a shallow sand dune deposit over terrace. The soil profile in this site shows four feet (1.2 m) of silty loam (A-4) soil overlying a sandy loam (A-4) soil.

Boring data along SR 37 from sites #170 to #173 is located on shallow sand dune deposit over sandstone-shale. The first four feet (1.2 m) at site #170 is a sandy loam (A-2-4) soil which consists of 76% of sand, 18% of silt and 8% of clay. The next two feet (61 cm) is also classified as sandy loam but the content of sand is decreased to 43% and the composition of silt and clay increased to 38% and 19% respectively. The soil is classified as (A-4) by the AASHTO classification. The underlying soil is a sandy loam composition for another five feet (1.5 m).

Site #171 is located 154 feet (50 m) from the center line of the road on a high spot which is more than 20 feet (6 m) above site #170. The profile shows that the top two feet (60 cm) is sand (A-2-4) which is composed of 87% of sand, 10% of silt and 3% of clay. The following four feet (1.2 m) is decreasing in sand content and increasing in silt and clay and classified as sandy loam (A-4) soil. Weathered soft sandstone is then encountered from 6 to 19 feet (1.8 to 5.8 m) before the hard interbedded sandstone and sandy shale strata is reached.

The influence of sandstone and shale bedrock can be recognized from the boring at site #172. The top eight feet (2.4 m)

is a sandy loam (A-2-4) soil, however, sandstone fragments are found between a depth from six to eight feet (2 to 2.4 m). The next two feet (60 cm) is a sandy loam (A-4) soil with the same composition as those mentioned in site #170. A four foot (1.2 m) layer of silty clay loam (A-6) soil is then encountered. This layer contains only 14% of sand but 57% of silt and 29% of clay. Below a depth of 14 feet (4.3 m) a shaly clay loam soil (A-4) is found. About 9% of the soil in this stratum is gravel size and the remaining soil sizes are 30% of sand, 43% of silt and 18% of clay.

Little or no problems other than stabilization and compaction are expected in the thick sand dune deposit. However, if deep cuts are required, the characteristic of the underlying material should be taken into account.

Cumulose Material

Four areas in Morgan County are mapped as cumulose deposit. Three of them are located in the Wisconsinan drift area and one is located on a terrace. The materials are quite different and discussed more in detail as follows:

1. Depression on Wisconsinan Drift

Three large depressions are recognized at the northwestern corner of Morgan County. They are extremely flat in topography and are slightly lower than the surrounding lands. The area shows a very dark and uniform photo tonality. Surface drainage from the surrounding lands flows toward these depressions. The upland materials are washed in by the surface water. The wash-in materials range from a silt loam at the edge to a silty clay loam at the center of the depression.

The soil profile in these depressions has a silty clay loam to clay topsoil with a high organic content and a plastic silty clay to clay subsoil. The calcareous clay loam to clay Wisconsinan till occurs at a depth from three to five feet (1 to 1.5 m) below the surface.

High mosture content and poor supporting power are the problems for engineers in this area.

2. Depression on Sandy Terrace Plain

A sizable depression is recognized on the sandy terrace plain located just southeast of Martinsville. The depression has a flat topography and only slightly lower than the surrounding terrace. The area also has a much darker photo tonality than the surrounding terrace.

In the main body of the depression the surface soil is high in organic matter and ranges from an organic clay loam to organic silty clay. The B-horizon varies from a silt loam to a clay. Clay loam and clay soil is encountered before the stratified sand, silt, gravel and clay parent material is reached.

The organic layer of topsoil should be removed before any structure can be built in this region. The poor supporting power at the B-horizon should also be taken into consideration in structural designs.

Residual Soils

Residual soils or colluvial soils in Morgan County occupy an area about 47 square miles (122 sq. km) or about 11.5% of the county. The residual soil of this county are subdivided into three groups, namely: the limestone soil, the sandstone-shale soil and the sandstone-shale with loess mantle soil. Details are discussed as follows:

1. Residual Limestone Soils

The residual limestone soils occur in the southwestern quarter of the county. Total area is about two square miles (5 sq. km). The largest area is located along the borderline with Monroe County. Other areas are located southwest of Wakeland.

The area along the border line of the county has a gently slopping surface toward West Fork White River. No noticable sinkhole appears in this area. Some surface drainage systems have been developed near the main gully. The areas south of Wakeland are situated along the gully walls adjacent to the thin Illinoian drift over limestone region. The area has a steep slope and is under thick forest cover.

On the flat upland area 18 to 48 inches (45 to 122 cm) of loess is found over the region. There is less than eight inches (20 cm) of loess deposit on the gully or valley wall region. The limestone in this area contains chert.

Soil profiles of this deposit show a silt loam to silty clay loam topsoil, a silty clay loam to clay subsurface soil and a silty clay to clay subsoil. A mixture of clay and chert may occur before the solid limestone bedrock is reached.

The problem associate with this region is primarily lack of adequate subgrade support as the subsoil is highly plastic in nature. Also, bedrock excavation is required in shallow cuts.

2. Residual Sandstone-Shale Soils

About 10% of the area in Morgan County belongs to the residual sandstone-shale soil region. The largest area is located in the south central part of the county. Large areas are located north of Mahalasville, north of Martinsville and north of Centerton. Two hills, namely the Maxwall Hill and the Gillmore Hill, are sandstone-shale hills of circumnavigation within the valley of West Fork White River. The rest of the sandstone-shale residual soils are scattered along the major valley walls, along the tributaries of West Fork White River and in the southwestern quarter of the county.

The topography of this soil region is extremely rugged. Hills and valleys are closely spaced with great local relief. Flat lands are limited to the narrow ridge tops and the flood plains of the deep valleys. Most of the area is used for timber lands.

The soils developed in this area are derived from a very thin layer of loess which ranges from nothing to 36 inches (0 to 90 cm) and the underlying interbedded sandstone-shale. The soil profile is complicated by the erosional condition. On steep slopes where the silt cap has been entirely removed a stony silt loam may be found and sometimes the underlying unweathered interbedded sandstone-shale may be exposed at or near the surface. At a steep valley wall a colluvial deposit may occur at the foot of the slope as illustrated near the bluff of West Fork White River north of Martinsville.

The normal soil profile consists of a fine sandy loam to stony silt loam surface layer followed by a stony silt loam or stony silty clay loam subsoil. The interbedded sandstone and shale is usually less than five feet (1.5 m) from the surface. The variation of texture of the soil depends entirely on the characteristic of the bedrock.

Highway cuts along SR 67 from sites #'s 78 to 84 show sandstone-shale rock exposure. At site #96 the profile shows 1.0 feet (30 cm) of topsoil followed by 2.2 feet (67 cm) of loam (A-4) soil before shale is encountered. Soundings taken near sites #'s 97, 98 and 99 shows that shale occurred at a depth of 1.5 to 6.0 feet (45 cm to 1.8 m) to more than 10 feet (3 m) on high ground. From sites #131 to #134 shale is encountered from one to five feet (30 cm to 1.5 m). The subsoil at the boring sites are weathered shale and sandstone. At site #131 the first five feet (1.5 m) is a clay loam (A-6) soil which contains 9% of gravel, 26% of sand, 45% of silt and 20% of clay. The next four feet (1.2 m) is also classified as a clay loam (A-6) but is coarser in texture. It is composed of 17% of gravel, 33% of sand, 32% of silt and 17% of clay. Further down in the profile a shaley clay (A-7-6) soil is encountered. This is a weathered shale which contains 1% of gravel, 6% of sand, 42% of silt and 51% of clay. At site #133, which is about 84 feet (25.6 m) higher than site #131, the profile shows the same surface texture for the first three feet (91 cm). A sandy clay soil (A-6) follows for the next four feet (1.2 m). The composition consists of 10% of gravel, 53% of sand, 1% of silt and 36% of clay. Sandy clay or soft weathered shale with the same (A-6) classification continue further down the profile. The hard shaley clay (A-7-6) is reached below a depth of 21 feet (6.4 m).

The engineering problems are associated with deep cuts and fills in different types of bedrock. The soil is susceptible to frost heaving and significant seepage problems occur in the interbedded sandstone and shale.

3. Residual Sandstone-Shale Soils with Loess Mantle

About 6.5 square miles (16.8 sq. km) in Morgan County is considered as residual sandstone-shale soils developed with a loess mantle. This soil is limited to the ridge top in the non-glaciated sandstone-shale region on the eastern half of the county.

Long and narrow sinuous ridge shapes is the characteristic form of the deposit. They occupy the highest position within the sandstone-shale region. The ridge is generally flat to gently sloping in topography. They are the only land suitable for cultivation within the sandstone-shale bedrock region.

The soil in this area is derived from a blanket of loess from 24 to 48 inches (61 to 122 cm) and the underlying bedrock. The soil is quite similar to the soil developed from thin Illinoian drift over sandstone-shale except that the weathered Illinoian till is missing from the profile.

The surface soil is generally a silt loam or a silty clay loam (A-4) soil. The B-horizon varies from silt loam to clay (A-6 to A-7) soil. Further down the profile more coarser textured clay loam or clay (A-6 to A-4) soil is found derived from the underlying bedrock. A layer of rock fragments mixed with clay is usually found before the interbedded sandstone-shale is reached. The bedrock is usually encountered at a depth from three to ten feet (1 to 3 m) depending to the topographic position.

Engineering problems usually are associated with deep rock cuts and fills when crossing from one ridge to the others.

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APPENDIX A

The soil test data tabulated below was obtained from consultants' reports prepared for the Indiana State Highway Commission. The location of the site is shown on the attached engineering soils map. Considerable additional data is contained in the consultants reports.

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
1	991+00	42 Rt	2.8-4.0	A-7-6(10)	Clay	0	10	47	43	41	27	14	17
			4.2-5.0	A-2-4(0)	Sa.L.	0	74	10	16	NP	NP	NP	--
			5.0-7.0	A-7-6(13)	Clay	0	37	33	30	48	22	26	19
2	995+00	42 Lt.	0.0-0.6	A-4(8)	Si.Cl.	0	12	56	32	32	22	10	22
			5.0-6.0	A-6(10)	Si.Cl.	0	7	57	36	36	21	15	17
3	1001+00	42 Lt.	0.8-2.0	A-4(5)	Loom	0	38	43	19	24	20	4	16
			8.0-10.0	A-2-4(0)	Sa.L.	0	72	8	20	NP	NP	NP	--
4	1001+10	42 Rt.	3.5-5.0	A-6(9)	Si.Cl.L.	0	20	52	28	31	18	13	13
5	1004+14	42 Rt.	6.0-8.0	A-6(9)	Clay	0	16	41	43	37	24	13	13
6	1007+00	42 Lt.	2.4-4.0	A-4(1)	Sa.L.	0	60	25	15	NP	NP	NP	--
7	1013+30	42 Rt.	0.8-2.0	A-6(9)	Clay	0	28	40	32	31	18	13	16
			2.2-4.0	A-6(8)	Clay	1	34	33	32	32	17	15	14
8	1016+00	42 Lt.	0.8-1.8	A-6(8)	Si.Cl.	0	13	55	32	31	20	11	15
9	1016+30	42 Rt.	5.5-6.0	A-6(10)	Si.Cl.	0	9	52	39	36	21	15	15
10	1019+15	42 Rt.	3.7-5.0	A-6(10)	Cl.L.	0	25	47	28	34	19	15	16
11	1022+00	42 Lt.	0-0.8	A-4(0)	Sa.L.	0	64	22	14	NP	NP	NP	--
			2.4-4.0	A-4(2)	Sa.Cl.L.	0	53	27	20	23	18	5	13
12	1028+00	42 Lt.	4.5-6.0	A-2-4(0)	Sa.L.	0	67	14	19	NP	NP	NP	--

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
13	1040+21	42 Rt.	0.8-2.0	A-7-6(19)	Clay	0	8	47	45	53	20	33	25
14	1043+00	42 Lt.	2.2-4.0	A-7-6(13)	Clay	0	10	49	41	42	20	22	18
15	1052+00	42 Rt.	4.2+6.0	A-7-6(16)	Si.Cl.	0	4	54	42	47	19	28	14
16	1070+30	42 Rt.	0.8-2.0	A-6(11)	Clay	2	21	40	37	37	19	18	13
			5.0-6.0	A-6(11)	Si.L.	1	26	57	16	35	16	19	12
17	1079+00	42 Lt.	2.8-4.0	A-4(8)	Si.Cl.L.	1	12	58	29	24	18	6	18
18	1088+00	42 Ft.	3.8-6.0	A-6(9)	Cl.L.	2	34	35	29	32	15	17	13
19	1091+00	42 Lt.	0-1.0	A-4(8)	Si.Cl.L.	0	25	53	22	31	22	9	19
20	1094+00	42 Rt.	0.5-1.0	A-7-6(13)	Clay	1	14	42	43	41	19	22	15
			2.0-3.0	A-7-6(14)	Si.Cl.	0	15	50	35	46	23	23	15
			6.0-7.5	A-4(6)	Loam	3	31	47	19	19	15	4	19
21	1097+00	42 Lt.	7.5-8.0	A-4(6)	Si.L.	0	34	55	11	NP	NP	NP	--
22	1100+00	42 Rt.	16.0-18.0	A-4(1)	Sa.L.	14	46	25	15	27	24	3	13
23	1103+00	42 Lt.	5.0-6.0	A-4(4)	Loam	8	36	36	18	18	13	5	11
24	1106+00	42 Rt.	16.0-17.5	A-4(4)	Loam	0	47	46	7	NP	NP	NP	--
			23.5-24.4	A-7-6(14)	Si.Cl.	0	2	57	41	43	20	23	18
25	1112+00	42 Rt.	1.2-2.4	A-7-6(15)	Clay	1	21	40	38	45	19	26	15
			2.4-4.0	A-7-6(20)	Clay	0	19	40	41	59	26	33	21
			4.2-6.0	A-6(11)	Clay	2	21	41	36	38	20	18	15
26	1121+40	42 Lt.	0.6-1.4	A-4(3)	Sa.Cl.L.	0	52	24	24	25	17	8	15
27	1136+00	42 Rt.	7.5-8.5	A-4(7)	Cl.L.	4	28	45	23	26	17	9	16
28	1142+00	42 Rt.	8.0-10.0	A-4(5)	Loam	11	28	44	17	21	19	2	13
29	1145+00	42 Lt.	3.5-5.0	A-6(6)	Clay	3	35	32	30	28	16	12	12
30	1148+00	42 Rt.	19.0-21.0	A-4(8)	Si.Cl.	0	3	65	32	31	22	9	19
31	1150+55	42 Lt.	0.8-2.0	A-6(10)	Cl.L.	1	31	47	21	38	19	19	12
			7.0-8.5	A-4(5)	Cl.L.	5	36	37	22	22	14	8	12

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
32	1153+00	42 Lt.	10.4-12.0	A-4(4)	Loam	6	38	41	15	17	13	4	13
33	1155+00	42 Rt.	14.0-16.0	A-6(9)	Si.Cl.L.	1	9	67	23	31	19	12	18
34	1157+00	42 Lt.	0-0.8	A-6(7)	Cl.L.	0	33	41	26	32	21	11	14
35	1174+00	42 Rt.	2.8-4.0	A-6(8)	Clay	3	30	30	37	31	16	15	10
			8.3-9.3	A-4(8)	Si.L.	1	21	66	12	24	16	8	13
36	1180+00	42 Rt.	7.0-8.5	A-4(8)	Si.Cl.	1	16	51	32	27	17	10	15
37	1221+00	42 Lt.	0-0.5	A-4(7)	Si.Cl.L.	1	27	50	22	25.6	20.8	4.8	7.7
			0.5-1.0	A-7-6(13)	Clay	0	13	44	43	44.6	24.5	20.1	14.6
			3.5-4.0	A-4(7)	Cl.L.	4	28	46	22	21.2	16.2	5.0	12.7
38	1230+00	42 Rt.	2.0-4.0	A-4(5)	Cl.L.	5	35	32	28	24.6	15.5	9.1	10.9
			4.0-5.0	A-4(1)	Sa.L.	6	54	28	12	17.0	14.3	2.7	10.4
39	1233+00	42 Lt.	6.0-8.0	A-4(6)	Cl.L.	5	32	36	27	25.9	16.6	9.3	11.4
40	1236+00	42 Rt.	4.0-6.0	A-6(10)	Clay	2	29	36	33	36.1	17.5	18.6	13.2
			9.5-11.0	A-4(8)	Si.Cl.L.	0	4	67	29	33.7	24.5	9.2	20.2
41	1242+00	42 Rt.	0-1.1	A-7-6(10)	Clay	0	17	43	40	41.9	26.2	15.7	14.3
			1.1-2.5	A-7-6(15)	Clay	0	15	39	46	48.3	24.5	23.8	12.7
42	1245+00	42 Lt.	4.0-6.0	A-6(9)	Si.Cl.	0	5	64	31	31.6	20.0	11.6	17.7
43	1251+00	42 Lt.	0-0.7	A-4(7)	Cl.L.	1	30	46	23	25.6	20.4	5.2	16.3
			1.2-2.2	A-7-6(17)	Clay	3	25	35	37	49.7	20.2	29.5	13.4
44	1254+00	42 Rt.	0.6-1.8	A-7-6(14)	Clay	0	11	49	40	45.8	23.7	22.1	17.1
			5.3-7.0	A-4(8)	Si.Cl.L.	6	14	55	25	26.5	16.0	10.5	14.3
45	1257+00	42 Lt.	3.8-5.2	A-6(7)	Cl.L.	4	32	40	24	28.2	15.7	12.5	11.6
46	1260+00	42 Rt.	6.0-7.0	A-4(8)	Si.Cl.L.	0	17	58	25	28.6	19.9	8.7	15.3
47	1263+00	42 Lt.	0.7-1.3	A-6(9)	Clay	2	24	39	35	32.6	20.0	12.6	14.1
48	1269+00	42 Lt.	7.0-8.0	A-2-4(0)	Sa.L.	5	66	14	15	NP	NP	NP	--
49	1281+00	42 Lt.	2.0-4.0	A-6(10)	Clay	2	32	29	37	38.0	18.8	19.2	13.4

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
50	1287+00	42 Lt.	0-0.5	A-4(7)	Cl.L.	0	29	45	26	27.8	20.8	7.0	13.5
			0.5-1.6	A-7-6(17)	Clay	1	20	34	45	49.5	21.2	28.3	11.2
51	1290+00	42 Rt.	1.8-3.3	A-7-6(15)	Clay	1	16	42	41	43.2	18.2	25.0	14.5
52	1293+00	42 Lt.	3.0-3.8	A-6(4)	Sa.Cl.L.	7	50	17	26	32.6	15.5	17.1	10.7
			3.8-4.5	A-2-4(0)	Sand	10	79	2	9	NP	NP	NP	--
			4.5-6.0	A-4(1)	Sa.L.	9	50	26	15	17.8	15.2	2.6	11.1
53	1302+00	42 Rt.	7.2-9.0	A-1-b(0)	Sand	13	73	10	4	NP	NP	NP	--
			11.0-13.0	A-4(7)	Si.L.	4	26	55	15	NP	NP	NP	--
54	1305+00	42 Lt.	1.5-3.0	A-6(10)	Clay	3	27	37	33	35.7	19.1	16.6	14.1
			5.0-7.2	A-6(4)	Cl.L.	2	44	28	26	27.8	16.5	11.3	12.9
			9.2-10.0	A-6(11)	Clay	1	8	41	50	35.0	17.8	17.2	12.3
			10.0-12.5	A-6(9)	Si.Cl.L.	1	5	66	28	33.5	21.3	12.2	16.4
			12.5-15.0	A-6(10)	Si.Cl.	0	9	53	38	33.7	19.6	14.1	14.7
55	1308+00	42 Rt.	7.0-9.0	A-4(8)	Si.L.	0	23	68	9	NP	NP	NP	--
56	1311+00	42 Lt.	6.0-8.0	A-4(8)	Si.L.	1	15	65	19	19.9	15.5	4.4	15.0
57	1317+00	42 Lt.	1.8-3.7	A-7-6(17)	Clay	0	14	38	48	46.7	16.1	30.6	12.5
58	1320+00	45 Rt.	4.0-6.0	A-6(9)	Cl.L.	1	31	41	27	31.1	14.5	16.6	13.3
59	1326+00	42 RT.	0.8-2.9	A-7-6(12)	Clay	2	34	27	37	41.2	17.2	24.0	12.9
			12.5-15.0	A-6(9)	Si.Cl.	1	10	51	38	33.8	22.3	11.5	17.0
60	1329+00	42 Lt.	2.2-4.1	A-6(9)	Si.Cl.	0	5	60	35	37.5	25.0	12.5	21.0
61	1335+00	42 Lt.	0-0.7	A-4(8)	Si.Cl.L.	0	14	63	23	30.0	22.5	7.5	18.8
			1.8-3.5	A-7-6(13)	Clay	2	21	40	37	41.0	18.4	22.6	13.5
62	1341+00	42 Lt.	3.5-4.1	A-2-4(0)	Sa.L.	1	77	9	13	NP	NP	NP	--
63	1344+00	42 Rt.	3.0-5.0	A-7-5(20)	Si.Cl.	0	3	53	44	61.5	31.3	30.2	19.2
			5.0-7.0	A-4(6)	Cl.L.	1	33	43	23	27.3	17.8	9.5	19.5
			7.0-9.0	A-2-4(0)	Sand	1	83	9	7	NP	NP	NP	--

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
64	1347+00	42 Lt.	0-0.7	A-7-5(14)	Clay	0	8	41	51	52.8	34.1	18.7	17.1
65	1350+00	42 Rt.	0.7-1.8	A-7-6(16)	Clay	1	16	39	44	45.7	17.3	28.4	10.7
			3.0-4.2	A-6(8)	Si.Cl.L.	0	24	50	26	30.1	19.4	10.7	15.5
66	1371+00	42 Lt.	0-0.8	A-6(8)	Clay	0	32	34	34	33.5	21.5	12.0	16.3
			4.5-6.0	A-4(5)	Cl.L.	1	37	32	30	26.4	17.1	9.3	10.7
67	1374+00	42 Rt.	0.5-1.5	A-6(9)	Clay	1	31	36	32	31.9	15.7	16.2	14.2
68	1377+00	42 Lt.	4.5-6.0	A-4(5)	Loam	3	36	46	15	NP	NP	NP	--
69	1383+00	42 Lt.	2.4-4.0	A-7-6(16)	Clay	7	19	32	42	49.8	23.8	26.0	19.8
70	1404+00	42 Rt.	9.0-12.0	A-7-6(15)	Clay	5	24	34	37	47.0	20.1	26.9	15.8
71	1407+00	42 Lt.	7.0-8.5	A-4(5)	Cl.L.	7	35	37	21	20.6	15.0	5.6	12.1
72	1416+00	42 Rt.	1.0-2.3	A-6(10)	Clay	1	19	47	33	37.5	21.6	15.9	8.3
			10.0-13.0	A-6(9)	Si.Cl.	1	14	50	35	32.0	19.9	12.1	17.1
73	1422+00	42 Rt.	0-1.0	A-6(8)	Si.Cl.	0	18	52	30	34.3	23.2	11.1	18.1
74	1428+00	42 Rt.	1.2-2.4	A-7-6(11)	Clay	3	34	27	36	42.3	18.9	23.4	13.0
75	1160+00	37 Rt.	0.2-2.0	A-7-6(14)	Si.Cl.	2	19	48	31	45	23	22	26
76	1174+50	37 Rt.	11.5-12.5	A-6(10)	Si.L.	0	10	71	19	35	21	14	22
			23.5-25.0	A-1-b(0)	Sand	0	83	17	0	NP	NP	NP	NP
			14.0-16.0	A-7-6	Si.Cl.						63	27	36
77	1178+00	37 Rt.	5.0-6.0	A-4(5)	Loam	0	48	34	18	21	NP	NP	NP
78	1187+00	42 Lt.	13.0-14.0	A-6(12)	Si.Cl.L.	3	21	48	28	40	20	20	22
79	1190+00	37 Rt.	5.0-6.0	A-6(9)	Si.Cl.L.	0	6	71	23	34	21	13	17
			7.0-8.0	A-7-6(12)	Si.Cl.	0	7	54	39	44	25	19	26
			10.0-12.0	A-2-4(0)	Sa.L.	2	66	28	4	18	NP	NP	NP
80	1199+00	37 Rt.	10.5-11.5	A-4(1)	Sa.L.	0	61	37	2	NP	NP	NP	NP
81	1201+00	37Rt.	9.5-10.0	A-4(6)	Si.L.	0	39	51	10	25	22	3	18

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
82	1204+00	42 Lt.	12.0-13.0	A-6(9)	Si.L.	5	22	55	18	32	21	11	19
			19.0-20.0	A-4(8)	Si.L.	4	27	55	14	29	21	8	24
			20.5-21.0	A-2-4(0)	Sa.L.	1	69	26	4	NP	NP	NP	NP
83	1207+00	37 Lt.	0.5-1.5	A-4(5)	Loam	0	47	44	9	20	17	3	21
84	1210+30	37 Rt.	9.0-10.0	A-4(4)	Sa.L.	0	50	38	12	21	17	4	15
			11.0-12.0	A-1-b(0)	Sa.L.	40	46	13	1	NP	NP	NP	NP
85	1219+00	37 Lt.	5.0-6.0	A-6(8)	Si.Cl.L.	3	14	62	21	32	21	11	19
86	1225+00	60 Lt.	2.0-3.0	A-4(8)	Si.L.	0	18	66	16	23	20	3	18
87	1250+00	50 Lt.	10.0-12.0	A-4(3)	Sa.L.	1	51	40	8	29	24	5	23
88	1257+00	37 Lt.	5.0-10.0	A-4(8)	Si.Cl.L.	2	20	54	24	27	19	8	16
89	1264+50	37 Lt.	4.0-8.0	A-2-4(0)	Sand	3	77	12	8	NP	NP	NP	NP
90	1267+10	37 Lt.	0-3.0	A-4(7)	Si.L.	2	35	48	14	29	22	7	24
91	1272+30	37 Lt.	4.0-6.0	A-1-a(0)	Sand	77	21	1	1	NP	NP	NP	NP
92	1283+90	80 Lt.	46.0-47.0	A-6(9)	Si.Cl.	0	10	58	32	32	19	13	15
93	1299+00	50 Lt.	3.0-4.0	A-6(2)	Sa.Cl.L.	0	61	16	23	28	15	13	14
			13.0-14.0	A-2-6(1)	Sa.Cl.L.	8	65	3	24	31	16	15	16
94	1301+70	60 Lt.	1.0-1.5	A-4(8)	Si.L.	0	6	75	19	25	20	5	15
			5.0-6.0	A-4(2)	Sa.L.	17	46	30	7	33	26	7	16
95	1309+75	20 Lt.	7.0-8.0	A-6(8)	Si.L.	0	7	80	13	28	17	11	22
			11.0-12.0	A-6(9)	Si.L.	7	11	64	18	31	19	12	21
96	1321+34	37 Lt.	1.0-3.5	A-4(3)	Loam	22	38	34	6	31	21	10	24
97	1330+00	37 Lt.	0.5-1.5	A-1-b(0)	Sand	37	51	8	4	20	15	5	14
98	1339+00	50 Lt.	1.0-3.0	A-7-6(11)	Si.Cl.L.	3	15	54	28	42	26	16	18
99	1351+00	10 Lt.	0.5-2.0	A-6(9)	Si.Cl.L.	1	12	64	23	33	21	12	22
100	1370+50	37 Lt.	15.0-16.0	A-6(9)	Cl.L.	3	61	36	37	38	19	19	15

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
101	1374+50	37 Rt.	19.0-20.0	A-4(8)	Si.L.	0	33	55	12	23	16	7	17
102	1378+30	37 Rt.	7.0-8.0	A-6(8)	Si.Cl.L.	0	9	70	21	35	24	11	22
103	1384+00	55 Rt.	5.0-6.0	A-4(6)	Loam	0	46	44	10	NP	NP	NP	NP
			19.0-20.0	A-1-b(0)	Sand	47	43	1	9	23	20	3	18
104	1392+00	37 Rt.	13.0-14.0	A-3(0)	Sand	2	91	4	3	NP	NP	NP	NP
105	1395+00	37 Lt.	13.0-14.0	A-1-b(0)	Sand	21	65	13	1	23	19	4	24
106	1405+00	37 Rt.	8.0-9.0	A-5(8)	Si.L.	1	35	53	11	41	32	9	26
107	1409+50	37 Rt.	10.0-12.0	A-2-4(0)	Sa.L.	40	46	10	4	20	19	1	19
108	1415+00	37 Rt.	1.0-2.0	A-4(4)	Sa.L.	0	53	30	17	23	20	3	18
			3.0-4.0	A-6(11)	Cl.L.	0	26	49	25	40	22	18	19
			5.0-6.0	A-7-6(13)	Si.Cl.L.	0	10	60	30	43	21	22	20
109	1418+50	37 Rt.	5.0-6.0	A-4(6)	Si.L.	0	43	57	0	23	21	2	25
110	1420+15	37 Rt.	0.3-2.0	A-4(8)	Si.L.	0	19	65	16	31	27	4	26
111	1431+00	37 Rt.	0.3-1.5	A-4(4)	Loam	1	46	43	10	19	15	4	14
112	1434+00	54 Lt.	3.0-4.0	A-4(2)	Sa.L.	10	51	25	14	23	17	6	14
113	1437+00	37 Rt.	2.0-4.0	A-6(11)	Si.Cl.L.	0	10	67	23	39	21	18	19
			5.0-6.0	A-2-4(0)	Sa.L.	0	75	16	9	NP	NP	NP	NP
114	1443+00	37 Rt.	9.0-10.0	A-4(4)	Loam	0	50	44	6	21	17	4	27
115	1445+00	37 Rt.	5.0-6.0	A-6(11)	Clay	0	19	48	33	36	19	17	15
116	1458+85	37 Rt.	5.0-6.0	A-4(1)	Sa.L.	51	30	15	4	30	24	6	25
117	1466+10	30 Rt.	2.0-4.0	A-4(8)	Si.L.	0	26	59	15	28	23	5	23
118	1470+00	25 Rt.	2.0-4.0	A-6(6)	Cl.L.	1	38	36	25	29	18	11	17
119	1477+00	15 Rt.	1.0-2.0	A-6(2)	Sa.L.	8	60	18	14	34	17	17	14
120	1486+00	CL	4.0-6.0	A-2-4(0)	Sand	0	90	6	4	NP	NP	NP	NP
121	1492+00	CL	2.0-4.0	A-1-b(0)	Sand	48	48	4	0	NP	NP	NP	NP
122	1546+00	40 Rt.	1.0-6.0	A-4(8)	Si.Cl.L.	1	16	56	27	32	23	9	19

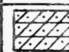
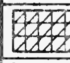
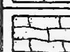
Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
123	1550+00	37 Lt.	4.0-6.0	A-4(8)	Si.L.	0	15	66	19	30	22	8	21
124	1557+00	37 Lt.	2.0-4.0	A-7-6(12)	Si.Cl.	0	4	53	43	44	27	17	20
125	1569+00	37 Lt.	4.0-6.0	A-6(12)	Si.Cl.	0	9	57	34	40	19	21	18
126	1600+80	37 Lt.	4.0-6.0	A-4(1)	Sa.L.	0	61	20	19	23	13	10	17
127	1606+00	37 Lt.	2.5-4.0	A-6(9)	Si.Cl.	0	6	62	32	29	17	12	16
128	1612+00	37 Lt.	4.0-6.0	A-6(11)	Si.Cl.	0	3	60	37	38	21	17	20
129	1632+00	37 Lt.	0-2.0	A-6(7)	Loam	16	34	36	14	38	24	14	25
130	1641+00	52 Lt.	10.0-12.0	A-6(11)	Si.Cl.	0	2	66	32	38	20	18	20
			16.0-18.0	A-7-5(15)	Si.Cl.	0	2	60	38	54	33	21	20
			20.0-21.0	A-6(10)	Si.Cl.	0	2	53	45	35	21	14	20
			23.0-24.0	A-4(8)	Si.Cl.L.	1	17	59	23	26	17	9	16
131	1650+00	44 Lt.	0-2.0	A-6(8)	Cl.L.	9	26	45	20	32	21	11	20
			7.0-8.0	A-6(8)	Cl.L.	17	33	32	18	34	23	11	19
132	1656+55	42 Lt.	2.0-8.0	A-6(11)	Clay	4	21	31	44	35	17	18	17
133	1664+00	50 Lt.	20.0-35.0	A-7-6(13)	Clay	1	6	42	51	42	20	22	20
134	1679+00	37 Lt.	1.0-2.0	A-6(4)	Sa.Cl.	10	53	1	36	40	23	17	18
135	1683+75	37 Lt.	6.0-8.0	A-6(8)	Si.Cl.L.	0	1	72	27	27	16	11	15
136	1686+00	50 Rt.	5.0-6.0	A-6(4)	Sa.L.	12	46	27	15	29	17	12	15
137	1693+65	45 Lt.	0.5-2.0	A-5(3)	Sa.Cl.L.	5	57	19	19	70	67	3	39
			5.0-6.0	A-1-b(0)	Sa.L.	22	60	14	4	NP	NP	NP	NP
138	1694+30	37 Rt.	5.0-6.0	A-1-b(0)	Sand	46	45	7	2	NP	NP	NP	NP
139	1713+33	50 Lt.	3.0-5.0	A-6(6)	Cl.L.	2	37	41	12	27	16	11	14
140	1720+15	45 Lt.	1.0-3.0	A-6(10)	Si.Cl.L.	2	12	62	24	37	22	15	23
141	1739+00	37 Lt.	6.0-8.0	A-7-6(14)	Clay	0	2	37	61	45	23	22	22
142	1745+00	160 Rt.	1.0-3.0	A-4(0)	Sa.L.	0	65	22	13	22	14	8	16
143	1748+00	37 Lt.	4.0-5.0	A-4(8)	Si.L.	1	29	52	18	26	19	7	20
			11.0-12.0	A-1-a(0)	Sand	55	49	4	2	NP	NP	NP	NP
			19.0-20.0	A-4(1)	Sa.L.	47	29	14	5	24	17	7	15

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
144	1757+50	37 Lt.	7.0-8.0	A-1-b(0)	Sa.L.	43	45	9	3	NP	NP	NP	13
145	1775+00	37 Rt.	0-1.0	A-4(7)	Cl.L.	1	33	46	20	22	16	6	20
			4.0-6.0	A-6(12)	Clay	3	31	33	33	38	16	22	16
146	1783+50	37 Lt.	0-1.0	A-6(11)	Clay	1	28	35	36	36	18	18	20
147	1796+00	37 Rt.	1.0-2.0	A-7-6(18)	Clay	1	28	37	34	51	21	30	21
148	1803+00	37 Rt.	6.0-7.5	A-2-6(1)	Sa.L.	3	70	27	0	28	13	15	15
149	1806+00	37 Lt.	2.0-3.0	A-6(5)	Sa.Cl.L.	3	52	23	22	32	17	15	16
			5.0-6.0	A-4(6)	Clay	5	35	24	36	23	13	10	13
			9.0-10.0	A-4(3)	Sa.L.	6	50	41	3	17	12	5	13
150	1817+00	37 Lt.	3.0-6.0	A-2-7(2)	Sa.L.	7	63	15	15	41	21	20	16
151	1837+00	37 Rt.	6.0-20.0	A-4(6)	Cl.L.	4	37	35	24	22	14	8	16
152	1847+50	37 Lt.	7.5-9.0	A-4(2)	Sa.L.	10	50	35	5	17	13	4	13
153	1851+00	37 Rt.	2.0-3.0	A-6(10)	Cl.L.	1	26	45	28	36	20	16	17
154	1852+80	38 Rt.	2.0-3.0	A-4(3)	Sa.L.	1	52	35	12	26	18	8	16
155	1856+00	46 Rt.	1.0-2.0	A-5(10)	Si.L.	0	18	79	3	48	38	10	16
156	1867+00	50 Rt.	4.0-6.0	A-6(7)	Sa.Cl.L.	14	46	22	18	39	17	22	15
157	1870+00	37 Lt.	0-1.5	A-6(8)	Cl.L.	11	42	23	24	37	17	20	16
158	1876+00	40 Lt.	0-1.0	A-4(8)	Si.Cl.L.	0	13	66	21	33	24	9	22
159	214+50	74 Rt.	0-2.0	A-4(5)	Cl.L.	2	41	32	25	25	18	7	
160	230+00	37 Lt.	2.0-4.0	A-2-4(0)	Sa.L.	10	65	11	14	25	17	8	18
161	236+65	37 Lt.	4.0-6.0	A-1-b(0)	Gr.Sa.	27	61	6	6	23	17	6	
162	251+00	88 Rt.	0-2.0	A-2-4(0)	Sa.L.	0	65	23	12	17	14	3	
			6.0-8.0	A-2-4(0)	Sand	3	80	15	2	NP	NP	NP	
163	261+00	37 Rt.	0-2.0	A-4(4)	Loam	1	42	38	19	28	18	10	
164	280+00	37 Rt.	2.0-4.0	A-2-4(0)	Sand	1	79	6	14	24	16	8	19
			6.0-8.0	A-1-b(0)	Sand	19	67	11	3	NP	NP	NP	

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
165	282+50	37 Lt.	1.0-1.5	A-2-4(0)	Sa.L.	2	64	21	13	23	16	7	
166	287+47	37 Lt.	4.0-5.5	A-6(3)	Sa.Cl.L.	1	49	25	25	31	20	11	17
167	291+15	37 Lt.	4.0-6.0	A-6(10)	Clay	0	27	42	31	38	22	16	26
168	315+54	70 Rt.	1.0-1.5	A-4(0)	Sa.L.	0	64	26	10	NP	NP	NP	
			2.0-2.5	A-4(3)	Sa.L.	0	50	35	15	28	20	8	23
169	317+50	30 Lt.	4.5-5.5	A-6(10)	Si.Cl.L.	0	14	57	29	39	25	14	24
170	356+00	37 Lt.	0-2.0	A-2-4(0)	Sa.L.	0	74	18	8	NP	NP	NP	
171	358+00	165 Rt.	0-2.0	A-2-4(0)	Sand	0	87	10	3	NP	NP	NP	
172	364+00	37 Lt.	14.0-16.0	A-4(6)	Cl.L.	9	30	43	18	26	20	6	21
173	370+50	100 Lt.	2.0-4.0	A-2-4(0)	Sa.L.	18	54	18	10	NP	NP	NP	
174	375+75	15 Lt.	1.0-2.0	A-7-6(13)	Si.Cl.L.	2	20	50	28	43	21	22	
175	378+30	42 Lt.	5.0-6.0	A-7-6(18)	Si.Cl.	0	6	52	42	50	20	30	
176	389+00	60 Lt.	7.0-8.0	A-2-4(0)	Sa.L.	1	66	18	15	NP	NP	NP	
177	403+00	21 Lt.	10.0-10.5	A-1-a(0)	Sa.Gr.	83	16	1	0	NP	NP	NP	

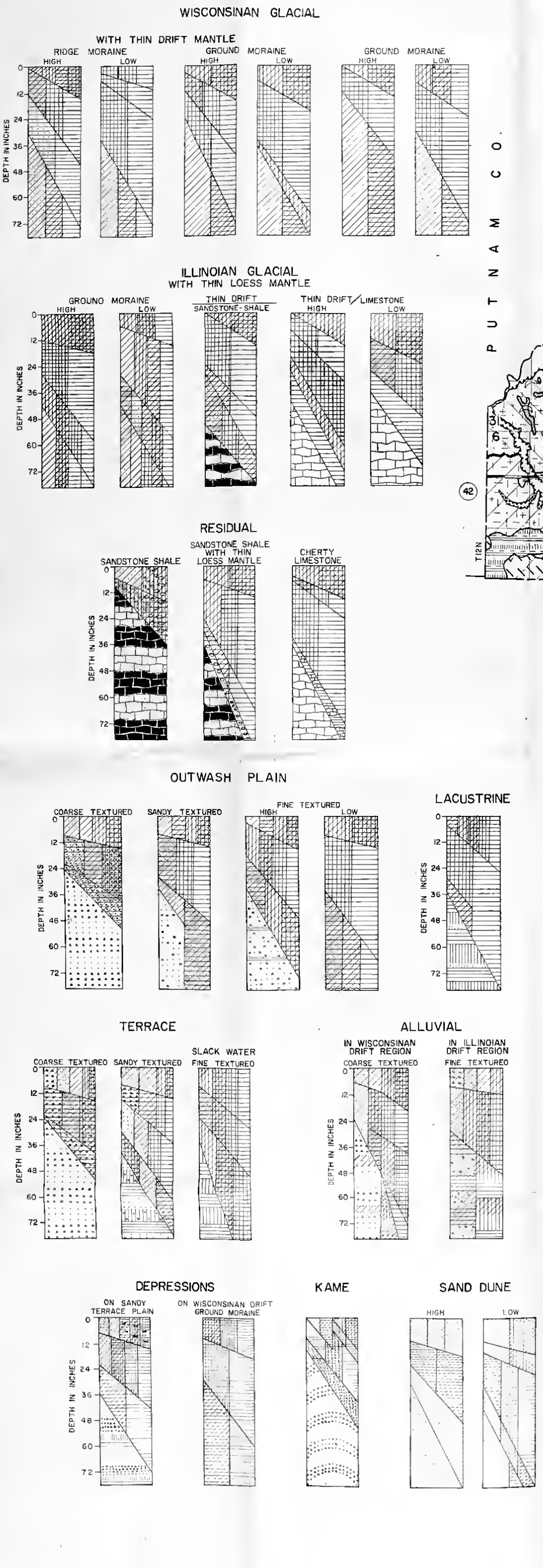
APPENDIX B

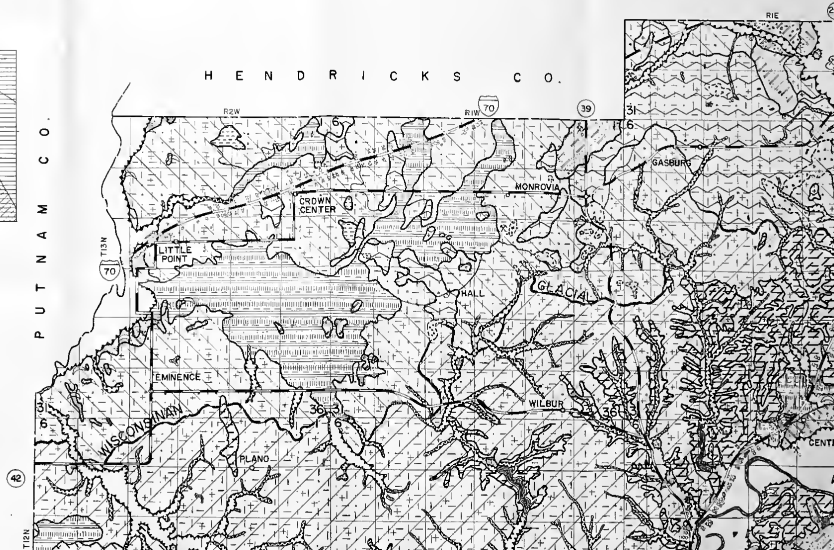
SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution				Plastic Index	Symbol
	Gravel % Retained on #10	Sand #10–#200	Silt 0.05–0.005mm	Clay Less than 0.005mm		
Gravel	85–100	0–15	0–10	0–10	NP	
Sandy Gravel	50–85	15–50	0–10	0–10	6 Max.	
Sand	0–15	85–100	0–10	0–10	NP	
Gravelly Sand	20–49	45–85	0–10	0–10	6 Max.	
Sandy Loam	0–19	50–80	0–50	0–20	6 Max.	
Sandy Clay Loam	0–19	50–80	0–30	20–30	10 Max.	
Sandy Clay	0–19	55–70	0–15	30–45	11 Min.	
Loam	0–19	30–50	30–50	0–20	10 Max.	
Silt Loam	0–19	0–50	50–100	0–20	10 Max.	
Silty Clay Loam	0–19	0–30	70–100	20–30	11 Min.	
Silty Clay	0–19	0–15	55–70	30–45	11 Min.	
Clay Loam	0–19	20–50	50–80	20–30	11 Min.	
Clay	0–19	0–55	0–55	30–100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only





ENGINEERING SOILS MAP

MORGAN COUNTY

INDIANA

PREPARED FROM

1939 AAA AERIAL PHOTOGRAPHS

BY

STATE HIGHWAY COMMISSION OF INDIANA

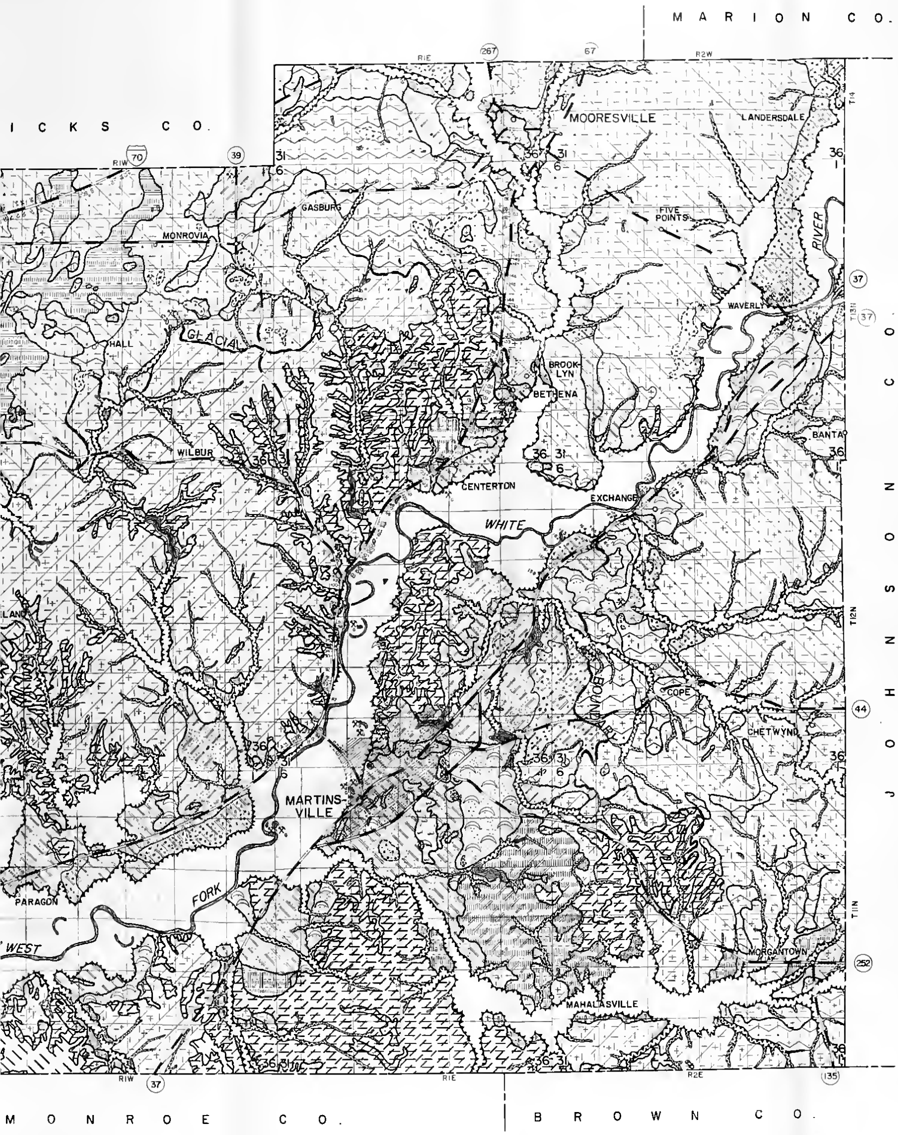
AT

PURDUE UNIVERSITY

1977

SCALE OF MILES

PREPARED UNDER THE SUPERVISION OF P T YEH



LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- GROUND MORAINE, ILLINOIAN
- GROUND MORAINE, WISCONSINAN
- RIDGE MORAINE, WISCONSINAN
- THIN ILLINOIAN DRIFT OVER INTERBEDDED SANDSTONE AND SHALE
- THIN ILLINOIAN DRIFT OVER LIMESTONE
- INTERBEDDED SANDSTONE AND SHALE
- LIMESTONE
- KAME
- SAND DUNE
- OUTWASH PLAIN
- TERRACE
- SLACK WATER TERRACE
- LACUSTRINE PLAIN
- THIN LOESS
- ALLUVIAL PLAIN
- LAKE AND POND

MISCELLANEOUS

- LIMESTONE QUARRY
- GRAVEL PIT
- SHALE PIT
- CLAY DEPRESSION
- HIGHLY ORGANIC TOPSOIL
- BORING SITES

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

- SILT
- CLAY
- LOAM
- SANDSTONE
- LIMESTONE
- GRAVEL
- SAND
- STONY
- SHALE
- HIGH ORGANIC

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SCALE OF MILES

1 3/4 1/2 1/4 0 1 2 3 4

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COVER DESIGN BY ALDO GIORGINI